

Ontario Toxics Reduction Program

Toolkit for Toxic Substance Accounting

Summary

To support the Ontario government's commitment to reduce toxic substances in air, land and water while promoting the green economy, the Ontario Ministry of the Environment has developed a comprehensive Toxics Reduction Strategy.

The Toxics Reduction Strategy (the "Strategy") is focused on:

- Reducing the use and creation of prescribed toxic substances to improve the protection of the environment and human health;
- Informing Ontarians about prescribed toxic substances in their communities; and
- Helping ensure that Ontario is well-positioned to compete in an increasingly green global economy.

The Strategy augments the traditional "end of pipe" approach to managing releases by focusing on reducing the use and creation of these prescribed toxic substances at the front end of the manufacturing process.

The Toxics Reduction Strategy promotes reductions in the use and creation of prescribed toxic substances to prevent pollution and to protect the health of Ontarians and the environment. The Strategy requires facilities to ensure that proper consideration is given to opportunities for reducing prescribed toxic substances while also recognizing that there may be essential and beneficial uses for some prescribed toxic substances. The intention of

the Strategy is not to compel facilities to reduce their production of goods or force them out of business. The Strategy does not restrict the use, creation, or release of prescribed toxic substances nor does it oblige facilities to implement reduction strategies as implementation of toxic substance reduction plans is voluntary.

The "Toolkit for Toxic Substance Accounting" (the "toolkit") provides information on complying with the toxic substance accounting requirements as set out in the Toxics Reduction Act, 2009 (the "Act") and Regulation 455/09 (the "Regulation"). The toolkit is intended to provide helpful suggestions for facilities as they implement the requirements of the Act and Regulation.

The tracking and quantification of prescribed toxic substances (i.e. toxic substance accounting) is valuable in determining:

- The extent to which a prescribed toxic substance is used or created at a facility and what happens to it as a result of the facility's activities;
- Aspects of the facility's operations which are good targets for reducing prescribed toxic substances; and
- A baseline to track progress in reducing prescribed toxic substances.

The list of prescribed toxic substances includes all the substances on the current federal National Pollutant Release Inventory (NPRI) Notices as well as acetone. In general, if a facility undertakes

manufacturing activities or mineral processing activities using chemicals and is required to provide information under the federal NPRI and/or report under Ontario Regulation 127/01, it is also subject to the requirements of the Toxics Reduction Act and Regulation 455/09.

Toxic substance accounting forms the basis for identifying toxic substance reduction opportunities and supports an informed analysis of identified reduction options. Therefore, the greater the quality of the toxic substance accounting information, the more informed the decisions regarding the viability of a reduction option will be. The owner and operator must thoroughly understand where, when, why and how a prescribed toxic substance is used and created at the facility. They must also understand, and be able to quantify: how much of the substance is contained in product; whether it is transformed into a different substance; whether it is destroyed; what is released via various output streams; and what is disposed of or transferred off-site. In addition to being a critical component of the overall toxic substance reduction planning process, toxic substance accounting is required in order to meet the annual June 1st reporting requirements.

Intended as a tool to assist the regulated community, this document details the toxic substance accounting requirements and is supplemented with possible approaches from specific manufacturing and mineral processing

activities to help illustrate how a facility might meet the regulatory requirements.

The Regulation is flexible in terms of how toxic substance accounting may be undertaken. Possible approaches are provided within this document to assist facilities in understanding the intent of the Act and Regulation and to help ensure they receive the most benefit from toxic substance accounting – namely, to understand toxic substance usage at their facility and the extent to which toxic reduction options may be identified and implemented. This includes, but is not limited to the following:

- How to document stages of a facility's operation that use or create a prescribed toxic substance and how to identify processes within those stages in order to meet the requirements of section 9 of the Act;
- How to develop process flow diagrams;
- What methods might be used for calculating process-level quantities of a prescribed toxic substance that are; used, created, transformed, destroyed, contained in product, released, disposed of and transferred;
- How to choose the best available method or combination of methods to track and quantify a prescribed toxic substance; and
- Understanding the purpose of an input-output analysis and how to use it to determine if a facility should revise or revisit any of the approaches in its accounting methodology.

This document includes a description of the toxic substance accounting requirements and provides both basic and complex examples to help illustrate how a facility may meet these requirements. The examples are intended to illustrate “real life” scenarios and show possible approaches a facility may employ to meet the toxic substance accounting requirements. A number of suggested approaches are outlined in this toolkit and examples have been provided to help identify possible best methods for characterizing substance use, creation, destruction, transformation, and contained in product.

The examples used throughout this document are possible approaches a facility may choose to consider in order to meet the requirements of the Toxics Reduction Act and Regulation 455/09.

As of January 1, 2010, the requirements of the Act and Regulation apply to the 47 Phase I priority substances and substance groupings. Based on the information collected for 2010, facilities are required to provide their first annual report to the ministry in June 2011.

Phase II begins on January 1, 2012, and the requirements of the Act and Regulation apply to all of the substances listed in the current NPRI Notices and acetone. Based on the information collected for 2012, facilities are required to provide their first annual report to the ministry by June 1, 2013.

This document provides information on complying with the toxic substance accounting requirements – a planning and reporting toolkit is currently under development.

While every effort has been made to ensure the accuracy of the information contained in this toolkit, it should not be construed as legal advice. In the event of a conflict between this document and the requirements identified in the Act and Regulation, the Act and Regulation will prevail.

For any addenda or revisions to this guide please visit the MOE website at:
<http://www.ene.gov.on.ca/>

or contact:

Public Information Centre (PIC)
Ontario Ministry of the Environment
Toxic Reduction Project
135 St. Clair Avenue West, 5th Floor
Toronto, Ontario
M4V 1M2

Telephone: (416) 325-4000 or 1-800-565-4923
TTY Toll Free: 800-515-2759
Fax: (416) 325-3195

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1.0 Introduction

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1.1 Background

The Toxics Reduction Act 2009 (the “Act”), is the cornerstone of Ontario’s Toxics Reduction Strategy. The Act requires **regulated facilities** to:

- Track and quantify their use and creation of prescribed toxic substances (toxic substance accounting);
- Develop a plan to reduce the use and creation of prescribed toxic substances;
- Make a summary of the plan available to the Ministry and the public;
- Report to the Ministry and the public on their progress in reducing prescribed toxic substances; and
- Review their plans on a regular basis.

Regulated facilities are prescribed by O.Reg 455/09 as facilities that undertake manufacturing or mineral processing (identified through NAICS codes that commence with “31”, “32”, “33” or “212”) and must provide information to the federal National Pollutant Release Inventory or O.Reg 127/01

The purpose and value of toxic substance accounting in the toxics reduction planning process is:

- To determine how and why a substance moves through various processes at the facility;
- To determine the baseline information needed to explore possible opportunities for toxics reduction at the facility,

- To determine the baseline information needed to report on amounts that are; used, created, contained in product, released, disposed and transferred on a facility basis; and
- To track and measure a facility’s progress in reducing prescribed toxic substances (where possible).

1.2 Scope of Toolkit

The toolkit provides clarification and suggestions on elements of toxic substance accounting through the use of various examples and approaches. Topics covered in this document include:

- Identifying and describing stages and processes at a facility that use and create prescribed toxic substances;
- Developing process flow diagrams that show the movement of a prescribed toxic substance for each process;
- Considering best available method or combination of methods for tracking and quantifying;
- Tracking and quantifying prescribed toxic substances at the process level;
- Input/output balances;
- A glossary of terms; and;
- A list of references

This document does not cover the requirements a facility may need to follow to determine if they are subject to NPRI or O.Reg 127/01. If a facility has any questions regarding this matter, they should contact:

National Pollutant Release Inventory

Environment Canada
10th Floor, Fontaine Building
200 Sacre-Coeur Blvd.
Gatineau, QC K1A 0H3

Tel: 1-877-877-8375

Fax: (819) 953-0461

E-mail: inrp-npri@ec.gc.ca

O.Reg 127/01: Airborne Contaminant Discharge Monitoring and Reporting (for acetone)

<http://www.ene.gov.on.ca/envision/monitoring/monitoring.htm>

This document is intended for the owner and operator (the persons ultimately responsible for ensuring compliance with the Act and regulation) of a facility captured under the Act as well as any person(s) who may assist them. The regulated community includes facilities in Ontario that fall under the North American Industrial Classification System (NAICS) Codes as listed in Table 1.

1.3 Toxic Substance Accounting Requirements in the Act and Regulation

Under Section 9 of the Act, the owner and operator of a facility are required to ensure for each process at the facility that uses or creates a prescribed toxic substance, that the substance is tracked and quantified, in accordance with the regulation, to show the following:

- how the toxic substance enters the process;
- whether it is created, transformed or destroyed during the process;
- how it leaves the process; and,
- what happens to it after it leaves the process.

Section 12 of the regulation outlines the information required to meet the objectives of toxic substance accounting such as the requirements for process flow diagrams (PFDs) and the quantities that must be accounted for. Section 12 of the regulation also prescribes the use of a best available method or combination of methods for tracking and quantification purposes (with certain considerations), and that the quantifications must be calculated at the process level. When reporting the quantifications in the annual report (submitted by June 1st), quantifications at the facility level are required.

Section 12 also refers to **records** that must be created during toxic substance accounting. These record requirements are explained throughout this document and a summary of the record requirements under the regulation is provided in Table 2.

The quality of the tracking and quantification of the amounts of substances, and the input/output balance are dependent upon: facilities having identified and described every stage of the facility's operation; determining the number of processes that use and create the prescribed toxic substance within a stage; the development of process flow diagrams which give the visual representation of the flow of the toxics substance through each process and the relationship of one process to another; as well as, the determination of the methods or combination of methods for tracking and quantifying the amounts of the prescribed toxic substances.

Table 1: NAICS for Regulated Community

NAICS	Subsector
212	Mining (see note below)
311	Food Manufacturing
312	Beverage and Tobacco Product Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Clothing Manufacturing
316	Leather and Allied Product Manufacturing
321	Wood Product Manufacturing
322	Paper Manufacturing
323	Printing and Related Support Activities
324	Petroleum and Coal Products Manufacturing
325	Chemical Manufacturing
326	Plastics and Rubber Products Manufacturing
327	Non-Metallic Mineral Product Manufacturing
331	Primary Metal Manufacturing
332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance and Component Manufacturing
336	Transportation Equipment Manufacturing
337	Furniture and Related Product Manufacturing
339	Miscellaneous Manufacturing

Note: NAICS 212 – (Mining, except oil and gas) – Applies to facilities that are using chemicals to separate, refine, smelt or concentrate metallic or non-metallic minerals from an ore. Mineral processing facilities that physically extract, grind, or crush (by non-chemical means) are not subject to the Act and Regulation.

Table 2: *List of Records Required to be Created for Each Toxic Substance under Toxic Substance Accounting*

Record No.	Regulation Section	Content of Record(s)	Annual Toxic Substance Reduction Plan Report ("Annual Report")	Toxic Substance Reduction Plan
Record #1	12 (2) 1 i and 12 (2) 1 ii	A description of every stage of the manufacturing operation at the facility that uses or creates the toxic substance A description of how each stage is divided into one or more processes that use or create the substance		✓ Due by the due date of the plan for the substance
Record #2	12 (2) 2 i and 12 (2) 2 ii	Process flow diagrams (PFDs) that give a visual representation of the movement of the substance through each process, including how it enters the process, whether it is created, destroyed or transformed during the process, how it leaves the process and what happens to it after it leaves the process Process flow diagrams (PFDs) that show the relationships between the processes		✓ Due by the due date of the plan for the substance
Record #3	12 (2) 3	The tracking and quantification of the substance for each calendar year in which Section 9 of the Act applies in respect of the substance	✓ To be used for the determination of the facility-wide quantities that are reported by June 1 of every year	✓ Due by the due date of the plan for the substance
Record #4	12 (2) 4	If the sum of the quantities of the substance that are used and created in a process in a calendar year does not approximately equal the sum of the quantities of the substance that are destroyed, transformed and leave the process, a record describing why the sums are not approximately equal		✓ Due by June 1 of the following year, but the record becomes part of the plan

Record No.	Regulation Section	Content of Record(s)	Annual Toxic Substance Reduction Plan Report ("Annual Report")	Toxic Substance Reduction Plan
Record #5	12 (2) 5	A description of the method or combination of methods used to track and quantify the substance in each process, and an explanation of why the method or combination of methods was chosen		✓ Due by the due date of the plan for the substance

Records developed in accordance with the accounting requirements support two other major requirements of the Act and regulation: facility-wide reporting and toxic substance reduction planning. This topic is discussed in greater detail under subsection 1.5 of this toolkit. While the majority of records are not required until the preparation of the plan, they are all interlinked and it may prove beneficial for a facility to begin all record development early in order to be ready for facility-wide reporting (due prior to the plan).

1.4 Linkages to NPRI and Ontario Regulation 127/01 – Airborne Contaminant Discharge Monitoring and Reporting

Ontario's Toxics Reduction Act and O.Reg 455/09 are closely interlinked with the federal NPRI program and O.Reg 127/01. Much of the work that facilities currently do to meet the requirements of these two programs may be leveraged to meet the requirements of toxic substance accounting. However, it is important to keep in mind the differences.

The prescribed toxic substances in the regulation include all of the substances on the current federal National Pollutant Release Inventory (NPRI) Notices as well as acetone (adopted from O. Reg 127/01 under the *Environmental Protection Act*). It should be noted that these substances are in the same form as specified by NPRI and/or O.Reg 127/01.

The substance and employee thresholds (including any applicable exemptions) are the same as NPRI and/or O.Reg 127/01 if the substance is acetone. This approach provides clarity to facilities attempting to determine if compliance with the Act and regulation is required.

For dioxins, furans and hexachlorobenzene, it is important to note that under the Toxics Reduction Act, 2009, reporting "no information available" is not allowed when reporting quantities for use, creation, contained in product, releases, disposals and transfers.

As noted previously, the requirements referred to as those belonging to NPRI are more accurately described in the current NPRI Notices. The regulation makes various references to the NPRI requirements.

Table 3: Comparison of accounting similarities and differences between the Toxics Reduction Act and NPRI & O. Reg. 127/01

Toxic Substance Accounting under O.Reg 455/09 and Toxics Reduction Act.	Similarities to NPRI & O.Reg 127/01	Differences from NPRI & O.Reg 127/01
Describing Stages and Processes	NPRI requires that the facility examine its operations more closely due to some of the rules that outline what activities are exempt for calculations to determine thresholds.	O.Reg 455/09 uses terms “stages” and “processes”, whereas NPRI uses “activities”
Process Flow Diagram	N/A	NPRI and O.Reg 127/01 do not require process flow diagrams
Considering Best Available Methods	Under O.Reg 455/09 the listed methods for consideration for best available methods are the same as those listed in NPRI.	NPRI and O.Reg 127/01 do not require “best available methods”
Changing Methods for tracking and quantification	Under prescribed circumstances, a facility may change its methods in O.Reg 455/09	NPRI and O.Reg 127/01 allow for changes of methods at any time. O.Reg 455/09 does not allow changes of methods unless: (a) there is a law that comes into effect prescribing a particular method; (b) during a review period of a toxic substance reduction plan – generally every 5 years.
Tracking and Quantification	Rules for calculations, including exemption in “things” and “activities” that are set out in NPRI also apply for accounting under TRA and O.Reg 455/09. Quantifications used for reporting are at the facility level	O.Reg 455/09 requires accounting to be conducted at the process level. NPRI and O.Reg 127/09 do not prescribe the level of detail for accounting methods. Under NPRI, a facility may report “no information” for dioxins, furans, and hexachlorobenzene. Under O.Reg 455/09 information on these substances is required using the best available method.
Input/Output Balances	N/A	NPRI and O.Reg 127/09 do not require an explanation if the inputs and outputs balances are not approximately equal.

1.5 Linkages to Planning and Reporting

Toxic Substance Reduction Plan (the Plan)

- Records prepared as part of the toxic substance accounting requirements are included in the Plan.
- Methods used and quantities determined through toxic substance accounting may be used to calculate a facility's reduction targets (if a facility chooses to set targets), as well as anticipated reductions in use, creation, contained in product, releases to air, land and water, disposals, and transfers of a prescribed toxic substance. This information is included in the Plan.
- Quantities from toxic substance accounting will be used to help calculate costs related to toxic substance use, creation, release, disposal, transfer, and contained in product. The costs are included in the Plan.
- After changing an existing process at a facility, a comparison of year to year toxic substance accounting figures may help a facility determine if their plan needs to be reviewed earlier than the fixed review date (i.e. 2018 and every 5 years thereafter). A definition of "significant process change" is provided in the glossary section. Further, a comparison of year to year toxic substance accounting figures may help facilities determine the amount by which prescribed toxic substances are being reduced as a result of plan implementation.

Toxic Substance Reduction Plan Report (the Report)

- Toxic substance accounting helps to determine the facility-wide values for the June 1st annual reports.
- Comparison of toxic substance accounting quantities from year to year may help facilities determine whether a "significant process

change" has occurred. If a significant process change has occurred, it must be documented in the Report.

- An indication of whether there has been a change in the method or combination of methods used to track and quantify a substance must be included in the Report. If there has been a change, a description of the change, the reason for the change, and how the change will impact future tracking and quantification of the substance must also be included.
- A statement indicating any incident outside of the normal course of events that occurred at the facility during the previous calendar year must be detailed in the Report. If the incident affected the results of the tracking and quantification of a substance an explanation of how it impacted the tracking and quantification must also be included in the Report.

2.0 Toxic Substances

The toxic substances for the purposes of the Toxics Reduction Act, 2009 and O.Reg 455/09 include:

- All of the substances and substance groups as listed in Schedule 1 of the current NPRI Notices; and
- Acetone, as listed in O.Reg 127/01.

These substances have been separated into two Phases in order to focus on priority toxics and carcinogens first. The requirements will be phased in as follows:

- **Phase I** substances consist of 47 “priority” substances and substance groupings, identified in Table A of the regulation and available in Appendix A of this toolkit. Based on the information collected for 2010, Facilities are required to provide their first annual report to the ministry in June, 2011.
- **Phase II** substances consist of the remaining substances listed in Schedule 1 of the current NPRI Notice, as well as acetone. Based on the information collected for 2012, facilities are required to provide their first annual report to the ministry by June 1, 2013.

Toxic substances can either be in pure form (as a chemical) or as a constituent or component of another chemical or product.

As stated previously, the substance and employee thresholds (including any applicable exemptions) as specified under NPRI, and O.Reg 127/01 for acetone, apply to the Act and regulation.

NPRI and O.Reg 127/01 also provide some exclusions with respect to quantifying for certain substances. For comprehensive information regarding these exclusions, please visit the NPRI web-site (<http://www.ec.gc.ca/inrp-npri>).

It is important to note that NPRI and O.Reg 127/01 update their requirements from time to time and that the Act and regulation apply to the most current requirements. It is the owner and operator’s responsibility to ensure that the most up-to-date NPRI Notice and/or O.Reg 127/01 rules are being used.

3.0 Overall Approach

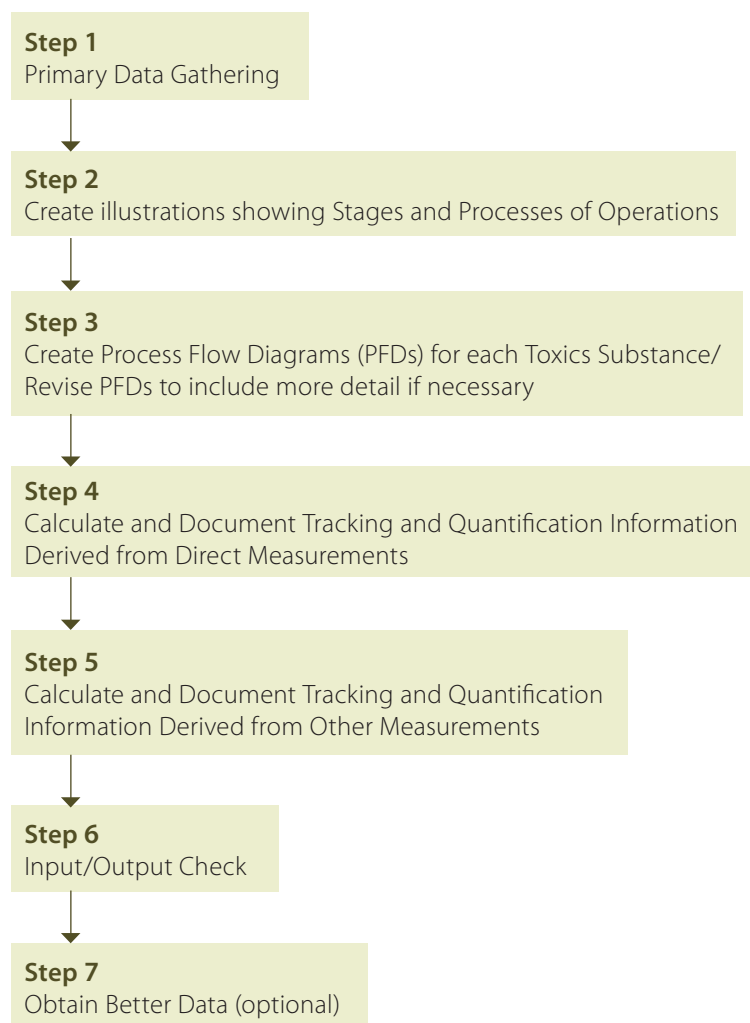
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The Act and regulation provide a facility with the flexibility to determine an appropriate approach to accounting and to ensuring that it is complete and accurate. The legal framework does not prescribe in what form information must be presented in the records. If the method or combination of methods a facility is using to acquire data for NPRI and/or O.Reg 127/01 reporting is the best available method, that facility may choose to continue to use the same method(s) to collect the additional data required to fulfill the requirements of the regulation.

One way in which facilities may begin undertaking accounting is to use a team approach. While this is not a requirement in the Act or regulation, staff from various areas of a facility may have information regarding a substance that may prove helpful in completing each of the required records. Appendix B provides further detail on how a team approach may be useful.

The illustration below may be a useful approach for facilities to apply.

Figure 1: Suggested Approach for Toxic Substance Accounting



3.1 Preliminary Data Gathering

Prior to developing the records that are required under accounting, a facility may undertake a preliminary data gathering exercise to assess what information it has on hand and what gaps may exist. This is particularly beneficial because under the Act, a facility may use documents developed for another purpose to meet the requirements of the Act and regulation (see section 45 of the Toxics Reduction Act for the actual provision).

The following suggestions may be useful to certain facilities:

- Undertake an exercise to inventory all raw materials and products used on-site and verify that a material safety data sheet (MSDS) is available and is up-to-date for any Workplace Hazardous Materials Information System (WHMIS) controlled products.
- Obtain MSDSs for any new WHMIS controlled products identified.
- Review the MSDSs and identify products that contain any amount of prescribed toxic substances for which thresholds have been met. For example, a facility that does metal fabrication and finishing may use several products that contain toluene, including paints, paint thinners, and adhesives. The paints and adhesives may be associated with different production lines. The toxic substance accounting for this facility must include the toluene from each product.
- Review MSDSs for reference to any substance that may be created through normal use of the product or that may be created under special conditions (such as temperature or pressure or mixing with other substances).
- For non-WHMIS controlled products such as feedstock materials, obtain product specification and/or results of analytical testing for chemical characteristics. The definition of feedstock is provided in the glossary section at the end of this toolkit.

Quantification methods relating to feedstock materials are also discussed in Section 5.2.

- Review all environmental monitoring reports (such as Municipal/Industrial Strategy for Abatement reports) and Certificate of Approvals to identify which output streams, from which operations, contain prescribed toxic substances.
- Review waste generator reports and analytical testing results of waste streams to determine which waste streams contain prescribed toxic substances.

Please note that Section 3.2 provides further guidance on the types of information available from various data sources.

Documentation of processes that may involve a prescribed toxic substance may exist with:

- process flow diagrams;
- schematics;
- site plan drawings showing the layout of equipment;
- mechanical or other drawings showing the location of floor drains and piping;
- drawings or Emission Summary and Dispersion Modeling (ESDM) reports showing the location of vents and air emission sources;
- spill reports;
- emergency preparedness plans showing the storage locations of hazardous materials;
- spill prevention contingency and countermeasure (SPCC) plans that identify where spillable materials are stored and in what quantities;
- standard operating procedures for receiving, transfers, storage, and use of products or waste containing prescribed toxic substances;
- standard operating procedures for equipment where products that contain prescribed toxic substances are processed (e.g. ovens, mixers, pressure vessels);

- equipment specifications and operating manuals; and
- publicly available data sources such as:
 - » United States (US) Environmental Protection Agency (EPA) Sector Notebooks (on-line resource)
 - » MOE Municipal/Industrial Strategy for Abatement (MISA) Development Documents
 - » Sector Specific Guidelines for Pollution Prevention, NPRI, Best Management Practices.

3.2 Data Sources

This section of the toolkit describes data sources that may be used to populate process flow diagrams and feed into the methods for tracking and quantifying prescribed toxic substances in each process (see Section 5).

Table 4 provides potential data sources for tracking and quantification. Sections 3.2.1 to 3.2.17 provide further information on the data sources.

3.2.1 MSDSs for Raw Materials

Material Safety Data Sheets (MSDSs) contain information regarding the presence, absence, and/or concentration of prescribed toxic substances in raw materials that are WHMIS controlled products. This information, found in “Composition and Information on Ingredients” of the MSDS, may be used along with the total raw material usage to calculate the quantity of a prescribed toxic substance entering a stage or process. In most cases, this information may be provided in ranges and it is up to the facility to decide which value they use (within the range) to meet the quantifications for accounting under the TRA, 2009 and O.Reg 455/09. It is suggested that when a facility decides on a particular value within a range that they remain consistent

from year to year. The “Physical and Chemical Properties” of the MSDS provides physical and chemical properties (such as evaporation rate or solubility in water) of a raw material, which may be useful with respect to tracking and quantifying a prescribed toxic substance’s path through a process. When an MSDS is available for a raw material, the facility may reasonably assume that the raw material received is homogeneous and that subsequent batches of the raw material contain the same concentration of the prescribed toxic substance.

The “Stability and Reactivity” and “Toxicological Information” of the MSDS may also provide information on prescribed toxic substances that may be created through normal use of the product or that may be created under special conditions (such as temperature or pressure or mixing with other substances. The “Regulatory Information” may contain prescribed toxic substances that are not listed in “Composition and Information on Ingredient.”

3.2.2 Purchasing Records and Production Numbers

Purchasing records will provide the total amount of a raw material purchased for the year. A facility’s “Consumables Reference List” will also provide information on raw materials consumed. Ideally, raw materials will be cost coded to a specific stage and process. Interviews with production-level staff may provide valuable information on the quantity of a raw material actually used and the ratio of raw material use to manufactured product.

It is important to reconcile purchased amounts with actual amounts used. In some cases, bulk chemical purchases are made for economic reasons, and there may be significant changes in chemical inventory amounts from year-to-year. These inventory changes may need to be

Table 4: Potential Sources of Data for Tracking and Quantification

Tracking / Quantification Requirement	Potential Data Source(s)	Section
Enters the Process (Use)	Data Sources	3.2
	MSDS	3.2.1
	Purchasing records and Consumable Reference List/Sheets	3.2.2
	Production numbers	3.2.2
	Monitoring data including continuous monitoring, source testing and other analytical testing results	3.2.8, 3.2.9, 5.1.3 to 5.1.5
Creation	MSDS	3.2.1
	C of A application documents	3.2.10
	Published documents on chemical properties	3.2.15
	Industry manuals, guidance documents	3.2.16
	EPA Sector notebooks	3.2.16
	Monitoring data including continuous monitoring, source testing and other analytical testing results	3.2.8, 3.2.9, 5.1.3 to 5.1.5
Destruction	Treatment /Abatement Equipment Specifications	3.2.14
	Monitoring data including continuous monitoring, source testing and other analytical testing results	3.2.8, 3.2.9, 5.1.3 to 5.1.5
Transformation	MSDS	3.2.1
	Equipment operating manuals	3.2.17
	Industry manuals, guidance documents	3.2.16
	C of A application documents	3.2.10
	Published documents on chemical properties	3.2.15
	Monitoring data including continuous monitoring, source testing and other analytical testing results	3.2.8, 3.2.9, 5.1.3 to 5.1.5
Contained in Product	MSDS for Product	3.2.3
	Product specification	3.2.4

factored into the toxic substance accounting to ensure that actual annual usages are not skewed by these inventory changes.

Amounts that are not used during a year and remain in storage are important to know. Storage may be considered a “stage” and/or “process” to provide clarity in how the substances flow through the facility even if certain amounts remain unconsumed.

3.2.3 MSDS for Manufactured Products

For a facility that manufactures a WHMIS controlled product, an MSDS is required. The “Composition and Information on Ingredients” of the MSDS for the product provides concentration information which may be used to quantify the prescribed toxic substance(s) contained in the product.

3.2.4 Manufactured Product Information

For manufactured items that are not WHMIS controlled products, but are exported, information required for export may be used. For example, for products exported to Europe, information on some of the substance content may be required for compliance with the European Union’s Restriction on Hazardous Substances Directive. Some design specifications (e.g. coating thickness specification) may also yield useful information for the quantification of a prescribed toxic substance. In addition, customer specifications may also yield useful information for quantification (e.g. customer requirement for certification of specific manufactured product quality).

3.2.5 Hazardous Waste Generator Registration Report

For facilities that generate hazardous or liquid industrial waste, a Hazardous Waste Generator Registration Report (GRR) must be submitted

to the Ministry of Environment. Part 2A of the GRR contains information regarding the source and characteristics of each waste stream, the quantities and methods of the waste processed or stored on-site, and the quantities and ultimate fate of the waste disposed off-site. This information may be used to estimate quantities of prescribed toxic substances in waste streams and track their ultimate fate. The GRR may identify which industrial processes created or transformed a prescribed toxic substance.

Note that with respect to determining off-site disposals and transfers of prescribed toxic substances, facilities may review NPRI’s toolbox for the best available methods (<http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=65A75CDF-1>).

3.2.6 Waste Manifests and Cost of Waste Disposal

For facilities that generate hazardous or liquid industrial waste off-site, their waste manifests may provide a valuable source of information. Waste manifests provide information regarding the characteristics and quantities of each shipment of waste transferred off-site, and the number of shipments. This information, along with that provided in the Hazardous Waste GRR, may be used to track and quantify off-site transfers of prescribed toxic substances in subject waste.

Information created to characterize waste for off-site disposal is often provided for aggregate waste and not for waste generated from specific processes. A waste receiver may undertake an initial and subsequent periodic analytical testing of the waste stream to confirm that the waste treatment facility can accept the material. Such analytical data is available to the generating facility.

The characterization methods for waste streams often involve a toxicity characteristic leachate

procedure (TCLP or leachate test) for solid wastes and a bulk chemistry test for liquids and sludge. This analytical data may help determine whether a prescribed toxic substance (such as lead) is contained in the waste stream. This data may show the presence of prescribed toxic substances that were created or transformed and therefore provide the opportunity for a facility to back-track through the process to determine how and under what conditions the prescribed toxic substance was formed.

Note that with respect to determining off-site disposals and transfers of prescribed toxic substances, facilities may use NPRI guidance available in the NPRI toolbox for best available methods.

3.2.7 Off-Site Transfer of Recyclable Materials and Cost

For recyclable material transfers that are not captured under O.Reg. 347 and its manifesting requirements, facilities may have a bill of lading or business record that identifies the off-site transfers. The amounts of prescribed toxic substances in these transfers should be quantified. Please note that with respect to determining off-site disposals and transfers of prescribed toxic substances, facilities may follow NPRI guidance for the best available methods.

3.2.8 Analytical Results of Effluent Water Quality

Sampling and analytical testing of wastewater and storm water may provide concentrations of prescribed toxic substances. These results may help determine the quantities of prescribed toxic substances being released from discrete processes within a facility, and as such may be useful for tracking and quantification.

Under the Municipal Industrial Strategy for Abatement (MISA) Effluent Monitoring and

Effluent Limits Regulations, industrial dischargers analyze samples from their wastewater discharge and report data based on the results.

Few municipal sewer-use by-laws require effluent sampling. However, municipalities often collect effluent samples at or downstream of industrial facilities to assess compliance with sewer use by-law limits. This data may be available to the industrial facility upon request.

Certificates of Approval (Industrial Sewage Works) under the Ontario Water Resources Act, often contain conditions that require that Certificates of Approval holders sample their discharge, analyze the discharge samples, and report data based on the results of the analysis of the samples.

Sampling that is required as part of a regulatory requirement is often only for “end-of-pipe” quality and not for a discrete process related to wastewater streams. However, this data may show the presence of prescribed toxic substances that were created or transformed and therefore provide the opportunity for a facility to back-track through the process to determine how and under what conditions the prescribed toxic substance was formed.

A facility may also have undertaken a wastewater characterization study that included the sampling of discrete wastewater streams as a result of one of the following:

- in order to complete a “waste survey” report as a sewer-use by-law requirement prior to discharge to sewer.
- as part of an initiative to better understand environmental impacts.
- as part of an initiative to identify where within a process a prescribed toxic substance is created.
- to identify source problems to address a non-compliance issue.
- testing done by consultants or suppliers to design treatment systems.

This data may be used to better understand what happens to a prescribed toxic substance throughout a process.

3.2.9 Results of Indoor, Ambient and Stack Air Testing

Air testing may provide concentrations of prescribed toxic substances in certain locations which may help determine the quantities of prescribed toxic substances being released from discrete processes within a facility, and as such, may be useful for tracking and quantification.

Ambient air or stack testing may be a condition on Certificates of Approval (Air) under the Environmental Protection Act and the information from the testing may also help with the quantification for toxic substance accounting.

Indoor air testing or industrial hygiene testing may be conducted as a result of a health and safety risk assessment or to address a worker complaint. If the intent of the industrial hygiene testing is to monitor a worker's breathing space during normal work functions and the sampling is conducted via a pump attached to the worker, the results may provide estimates to determine air concentrations, and/or emissions of the substance into air.

It may also provide an overall indication of whether a prescribed toxic substance (such as lead) is being used or created in the process. If sampling is conducted via a pump (drawing air through a filter media or into a bag for later testing) at a fixed location in the facility, then this information may provide concentration levels of prescribed toxic substances. In both cases, this data may show the presence of prescribed toxic substances that were created or transformed and therefore provide the opportunity for a facility to back-track through the process to determine how and under what conditions the prescribed toxic substance was created or transformed.

3.2.10 Certificate of Approval (Air) and Application Documents

The facility's documentation originally submitted in support of the application for a Certificate of Approval (Air) normally includes an Emission Summary and Dispersion Modeling (ESDM) report which contains a description of the process, sources of air emissions and contaminants that may be emitted. The supporting documentation may also include equipment specifications, operating conditions, and operation manuals for equipment such as ovens, thermoforming and extrusion equipment, granulators, mixers, and cyclones. All of the toxic substances set out in the regulation would be considered "contaminants" under the EPA. Therefore, a facility that has undergone the Certificate of Approval application process may have already partially determined, for processes that emit a prescribed toxic substance to the environment, when a prescribed toxic substance is created, transformed or destroyed and under what operating conditions (temperature, pressure) these activities occur.

The information contained in the documentation originally submitted as the C of A application supporting documentation may be used to determine process-related releases of a prescribed toxic substance as well as provide information regarding industry standards for determining transformations and releases. However, it should be noted that these determinations are based on "worst case scenarios" to demonstrate compliance with point of impingent standards and as such may not be directly applicable for quantification under toxic substance accounting.

3.2.11 NPRI report

A facility's NPRI report will provide quantification of the total releases of a prescribed toxic substance to air, water and land, disposals and transfers. These values are calculated in accordance with

NPRI guidance, and may be used when quantifying the amounts that enter the process, are created, and are contained in product. Depending on the methods used to acquire data to report to NPRI and the source of the data to support the calculations (ie. process level data “rolled-up” to the facility level for the purpose of reporting to NPRI), supporting documents and calculations for the NPRI report may be a good source of information for tracking and quantification.

3.2.12 O.Reg 127/01 report and associated calculations

A facility’s O.Reg 127/01 report will provide quantification of the total emissions of acetone to air, water and land disposals and transfers. These values are calculated in accordance with O.Reg 127/01 guidance, and may be used when reporting outputs.

3.2.13 Spill reports

Spill reports provide information regarding the source, circumstances, identity, quantity, time frame and ultimate fate of substances that have been spilled or accidentally released. This information may be used to identify, track and quantify prescribed toxic substances that have been lost from specific processes to spills. Spill reports provide an opportunity to better understand normal operations and maintenance activities and what may go wrong; and therefore, provide opportunities for improvement in equipment maintenance, storage, transfers, etc. Spill reports containing analytical testing results of spilled materials may also show the presence of prescribed toxic substances that were created or transformed; and therefore, provide the opportunity for a facility to back-track through the process to determine how and under what conditions the prescribed toxic substance was formed.

3.2.14 Treatment/Abatement Equipment Specifications

Design briefs, equipment specifications and warranty statements may provide data for use in toxic substance accounting. For example, if a paint booth air filter has a stated efficiency for a specific application and it is maintained as per specifications in the operations and maintenance manual, then this efficiency rating may be used to determine the amount of prescribed toxic substance in the air released from the paint booth and what remains in the filter.

3.2.15 Other Documents/Information Sources on Physical and Chemical Properties of Toxic Substances

Chemistry and toxicology textbooks such as the CRC Handbook of Chemistry and Physics and The Merck Index provide valuable information on the properties of prescribed toxic substances such as evaporation rates, solubility in water, stability and reactivity. This information is useful in determining how prescribed toxic substances can be transformed or destroyed. The “Handbook of Environmental Data on Organic Chemicals” by Karel Verschueren also provides information on organic chemical use and formulations, transformations, natural sources for occurrences, human or anthropogenic caused sources, and methods for sampling. The US Agency for Toxic Substances and Disease Registry also provides information on sources and methods for sampling prescribed toxic substances.

Online resources may also be useful and include but are limited to the following:

- Canadian Centre for Occupational Health and Safety (<http://www.ccohs.ca/>)
- Chem Info (<http://ccinfoweb.ccohs.ca/cheminfo/search.html>)

- Hazardous Substance Data Bank (<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>)
- US Environmental Protection Agency (<http://www.epa.gov/>)
- Additional resources may be found in section of the toolkit

3.2.16 Documents/Information Sources on Typical Processes and Fate of Toxic Substances

There are a number of sector specific guidance documents, notebooks and resources that describe typical processes, prescribed toxic substances used and created, along with their fate.

A Ministry Municipal/Industrial Strategy for Abatement (MISA) Development Document is available for each of the MISA sectors. These documents provide information on principal raw materials, descriptions of the processes, and flow diagrams showing stages and processes for Ontario industries in these sectors. In addition, a reference section directs the reader to more detailed sources of information on processes.

The United States (US) Environmental Protection Agency (EPA) Sector Notebooks are an on-line resource for several sectors. These Sector Notebooks are an excellent resource providing information on raw materials, descriptions of processes, characteristics of inputs and output streams, and pollution prevention options.

US EPA AP-42 is a compilation of air emission factors. This data source provides process descriptions and may also provide ranges of prescribed toxic substance concentrations in raw materials. For example, US EPA AP-42, Section 11.3 provides a typical range of the concentration of fluorine that is found in the feedstock for brick making.

Information on processes, input and output streams, and pollution prevention options may also be found in various government technical resource documents such as:

- Environment Canada's Technical Resource Guide Prepared to Assist Wet Processing Textile Mills Required to Prepare and Implement Pollution Prevention Plans
- EPA Guides to Pollution Prevention – The Commercial Printing Industry
- City of Toronto, Environmental Regulations and Best Management Practices For Petroleum Facilities in the City of Toronto
- MOE, Best Management Practices, Dry Cleaning and Laundry Services
- NEWMOA, Pollution Prevention in Machining and Metal Fabrication, A Manual for Technical Assistance Providers

Information on tracking and quantification may also be found in guidance documents on NPRI, pollution prevention, etc., published through industrial trade associations such as the Canadian Plastics Industry Association, the Ontario Mining Association, the Chemical Industry Association of Canada (formerly Canadian Chemical Producers Association), the Canadian Association for Surface Finishers, Canadian Vehicle Manufacturers Association etc.

3.2.17 Process Equipment Specifications and Operating Manuals

Design briefs, equipment specifications and warranty statements for process equipment may provide data for use in toxic substance accounting. This data includes such things as oven operating temperatures, process flow rates, pH of baths, coating application efficiency rates, product application rates, etc. An equipment supplier may provide "Consumable Reference Sheets" for their product which outline the amount a "consumable" will be used.

4.0 Stages and Processes

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The intent of the regulation to require the owner and operator of a facility to identify and describe stages and processes is to gain a better understanding of how the substance flows through its operation.

A facility may already have some form of illustration or description of its operation that describes the manufacturing of their product or material flow. While this information may be used, it is important to keep in mind that the Toxics Reduction Act focuses on the substance and how it flows through the facility, not necessarily the flow of products.

4.1 Identifying and Describing Stages and Processes

The Regulation requires that:

*"... the owner and the operator of a facility shall create the following **records** in respect of the toxic substance:*

1. A record that describes,
 - i. every stage of the manufacturing operation at the facility that uses or creates the substance, and
 - ii. how each stage is divided into one or more processes that use or create the substance.

(O. Reg. 455/09, s. 12 (2) 1")

2. A record that includes process flow diagrams that,
 - i. give a visual representation of the movement of the substance through each process, including how it enters the process, whether it is created, destroyed or transformed during the process, how it leaves the process and what happens to it after it leaves the process, and
 - ii. show the relationships between the processes."

(O. Reg. 455/09, s. 12 (2) 2)

The Regulation further states that:

"In determining how many processes a stage of the manufacturing operation should be divided into... the owner and operator of the facility shall ensure that a sufficient number of processes are identified for that stage to enable the owner and the operator to meet the requirements set out in section 9 of the Act and this section."

(O. Reg. 455/09, s. 12 (3))

Stages describe the facility's operation from a higher level and processes describe the substance's flow at a more detailed level. Figure 2 provides an illustration showing the difference between these two concepts. It is up to the facility to determine the level of detail since each facility is unique and may experience varying levels of complexity in the way the substance flows through the facility.

4.2 Identifying and Describing Stages of the Operation

There are many approaches that a facility may take in meeting the requirement to describe stages that use and create a substance. However, a useful starting point may be to identify *all major aspects* of an operation, regardless of whether all stages use or create a specific prescribed toxic substance. An added benefit to this approach is that if a facility has multiple substances to account for, a single "master" document may be developed and then referred to in the record for a particular substance as long as it meets all the requirements.

Because "stages" generally depict a higher level perspective, one approach to identify and describe stages of the facility's operation is to first consider how the facility divides up its operation from a business management perspective.

Figure 2: *Illustrating the differences between stages and processes*



A typical operation may first be divided into the main production operations, and ancillary operations. The stages associated with each of these operations could then be listed, as shown in the following examples.

Example: Stages of a Facility's Main Production Operations

- Receiving
- Warehousing or Storage
- Preparation or Staging
- Production Line

- Packaging
- Shipping

Example: Stages of a Facility's Ancillary Operations

- Water or wastewater treatment
- Maintenance shop
- Tooling or die shop
- Operation of boilers, compressors

Figure 3 shows an illustration that reflects the above-listed "Example: Stages of a Facility's Main Production Operations", where each box represents a stage:

Figure 3: Illustration for “Example Stages of Facility’s Main Production Operations”



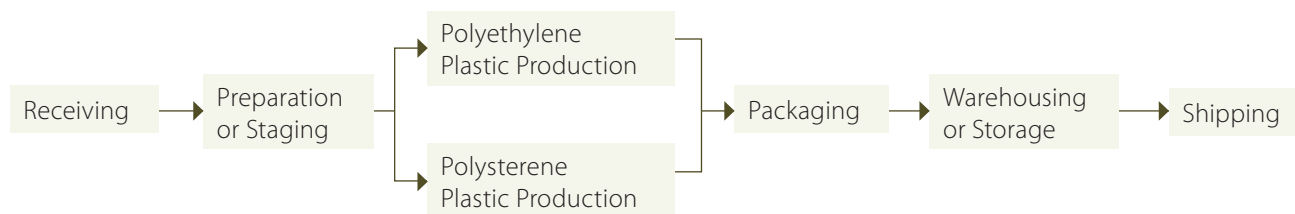
The advantage of using an illustrative approach over a textual one is that it helps start the thinking process about the flow of the prescribed toxic substance from one stage to another. This may help in developing process flow diagrams later on. However, the format for describing and identifying the processes under the stages is entirely at the facility’s discretion.

In the example above, the production operations are fairly easy to describe with a simple illustration because the stages are linear and continuous. Periodically, substances are introduced at one end and periodically,

substances leave in the finished products at the other end.

For facilities with multiple products where there are parallel activities related to the individual products, a facility may consider each product line to be a separate manufacturing stage (or group of stages). For example, if a plastics manufacturing facility manufactured different types of plastic, each production line could be separated into its own stage. Figure 4 provides an illustration showing stages that reflects this example.

Figure 4: Example Illustration Showing Unique Stages for Production Lines



If the facility has chosen to identify all the stages in its operation (showing both stages that use and create the substance and those that do not), an indication of the stages that use or create

a prescribed toxic substance is useful. Figure 5 provides one example of how this information might be illustrated, (building on Figure 3):

Figure 5: Identification of Stages that Use or Create A Toxic Substance

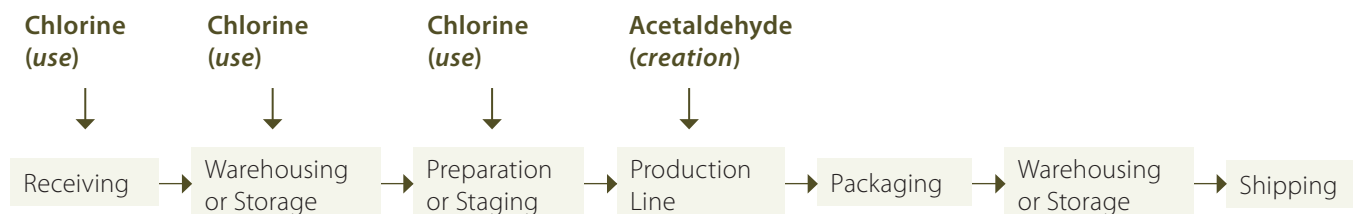


Figure 5 shows the *use* of one prescribed toxic substance, and the *creation* of another prescribed toxic substance in certain stages of the manufacturing operation. This is an example of how a master stage diagram may be used for multiple substances. More discussion on approaches for grouping substances that flow or move together, including an example, can be found in appendix C. However, for the purposes of the regulation, the record for each substance would need to reference the master stage diagram in order to meet the requirement.

The purpose of describing the stages that use or create a substance is to:

- Stimulate thinking about the substance and how it moves through the operation of a facility;
- Determine how the stage can be further broken down in order to identify processes; and
- Ensure the details of operations for the baseline year are captured to a degree that future changes to operations are obvious.

It is suggested that sufficient detail be provided in the descriptive text. Answering what, where, how, why and when about the use and creation of a prescribed toxic substance may be considered as one approach. Specific detail that may be included in the text includes answers to the following questions:

- Which production stages and processes use products that contain the prescribed toxic substance? What is the purpose of the substance(s)?
- How is it received, in what quantities, and how frequently?
- Where and how is it stored and how is it transferred for use?

- In what operations is it used? Why is that particular product required? Is it used in a continuous operation or a batch operation? During how many shifts?
- In what operations is the prescribed toxic substance created?
- What happens to the prescribed toxic substance? Does it become part of the manufactured product? Does it end up in a waste, air, or wastewater stream? Does it get transformed into another prescribed toxic substance or it is destroyed?

Figure 6 provides an example of a record for the description of stages, divided into a number of processes, for a fictional brick manufacturing facility for hydrogen fluoride.

While the example in figure 6 provides stages and processes that do not use or create the substance (in this case hydrogen fluoride), the illustration may be of benefit to provide an overview of the entire operation. For the purposes of the Act and regulation, a facility would need to identify and describe the “production stage” and then focus on the “drying process” and the “kiln firing and cooling process”.

Figure 6: Illustration Showing Stages and Processes for Fictional Brick Manufacturing Facility for Hydrogen Fluoride

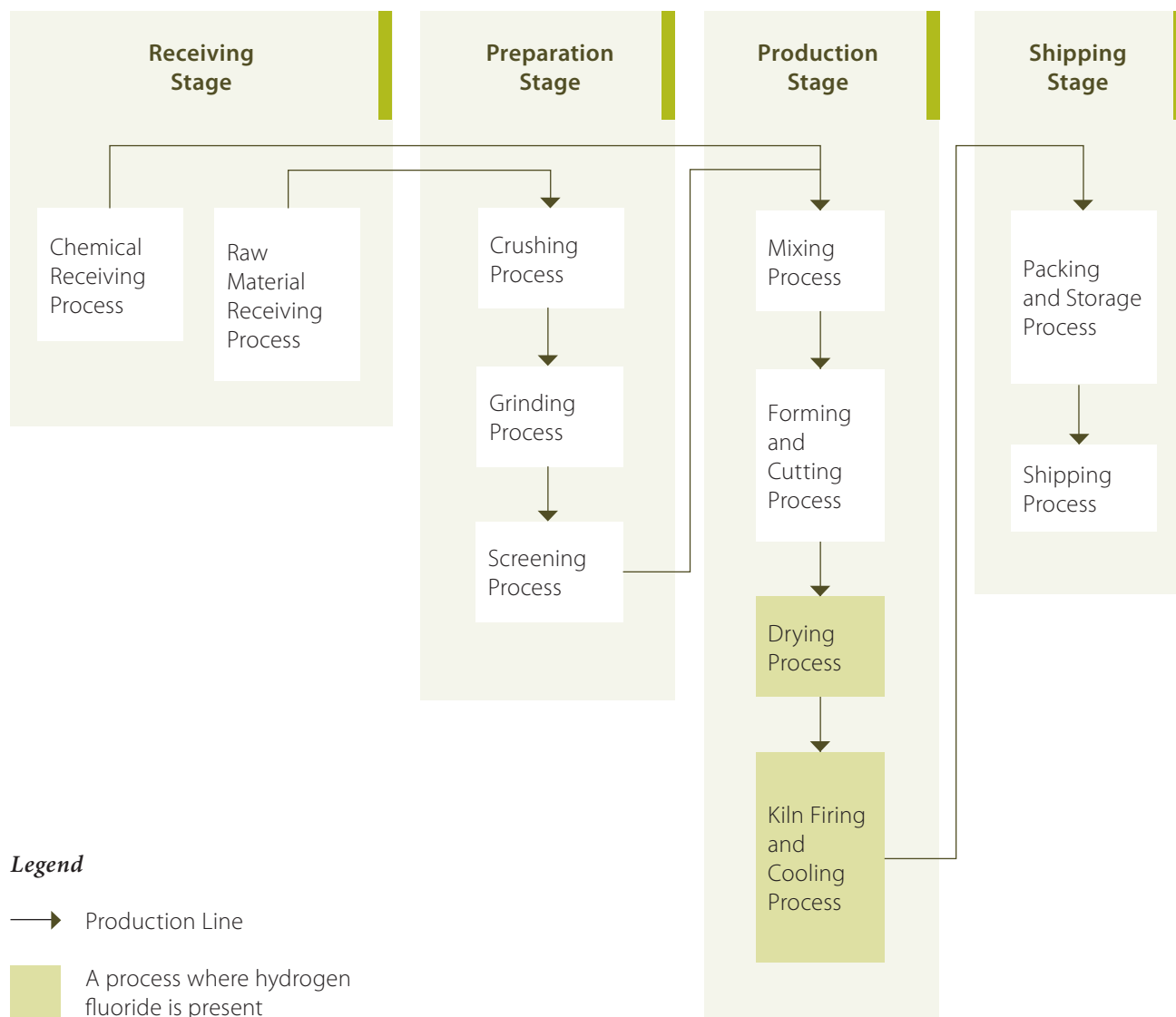


Figure 6 Description

Hydrogen fluoride is a by-product of fluorine. Fluorine is introduced as a constituent in the natural raw materials (including clays and shales). Assay tests show a range of fluorine concentrations from 0.02 to 0.05 percent by weight for the raw material received in 2010. During the **raw material receiving process** of the **receiving stage**, the raw materials are received in bulk by covered dump trucks from an on-site quarry, are dumped into a hopper which transfers the raw material via an underground conveyor system to a storage area. Chemicals such as pigments are received during the **chemical receiving process** via truck and are transported to a storage area via forklift. During the **preparation stage**, the raw material passes through the **crushing, grinding and screening processes** by mechanical means. During the **production stage**, the ground, screened clay and shale is mixed with water to a desired consistency, and pigments are added to customers' specifications. In the **forming and cutting process**, the mixture is extruded and cut by mechanical means, into bricks sized according to customers' specifications. The bricks from the forming and cutting process enter the drying process to remove excess moisture from the bricks. The dryers typically are heated to approximately 400 deg F (200 deg C) using waste heat from the cooling zone of the kiln. The dried bricks are collected from the **drying process** and loaded into the **kiln firing and cooling process**, where the bricks are fired to temperatures reaching between 500 and 600 degrees Celsius. During both the drying process and the kiln firing and cooling process, some of the fluorine present in the bricks is transformed to hydrogen fluoride gas by dehydroxylation. Hydrogen fluoride gas is collected and treated using a dry scrubber containing limestone. The

cooled bricks are transferred to the **shipping stage**, where they are packed, stored and eventually shipped.

The brick manufacturing facility generally operates year-round, 24 hour per day, 7 days per week, with the exception of scheduled maintenance. Most of the processes run continuously, with the exception of the drying process and kiln firing and cooling process, which are batch processes that shut down between filling and emptying, since the dryers and kilns must be full before they are run.

4.3 Identifying and Describing Processes of the Operation

The Regulation requires that:

*"... the owner and the operator of a facility shall create the following **records** in respect of the toxic substance:*

2. A record that includes process flow diagrams that,

i. give a visual representation of the movement of the substance through each process, including how it enters the process, whether it is created, destroyed or transformed during the process, how it leaves the process and what happens to it after it leaves the process, and

ii. show the relationships between the processes."

(O. Reg. 455/09, s. 12 (2) 2)

To determine what is required to describe the processes that use and create a substance, the facility should look at the Act and the regulation together. The Act requires a description that may be provided textually, and the regulation requires a visual representation to describe the movement of the substance.

Specific detail that may be included in the text includes answers to the following questions:

- How and why does the prescribed toxic substance enter the process?
- Where in the process is the prescribed toxic substance created? How is it created? When is it created? Why is it created? Under what conditions?
- What happens to the prescribed toxic substance? Does it become part of a product? Does it end up in a waste, air, or wastewater stream? Does it get transformed

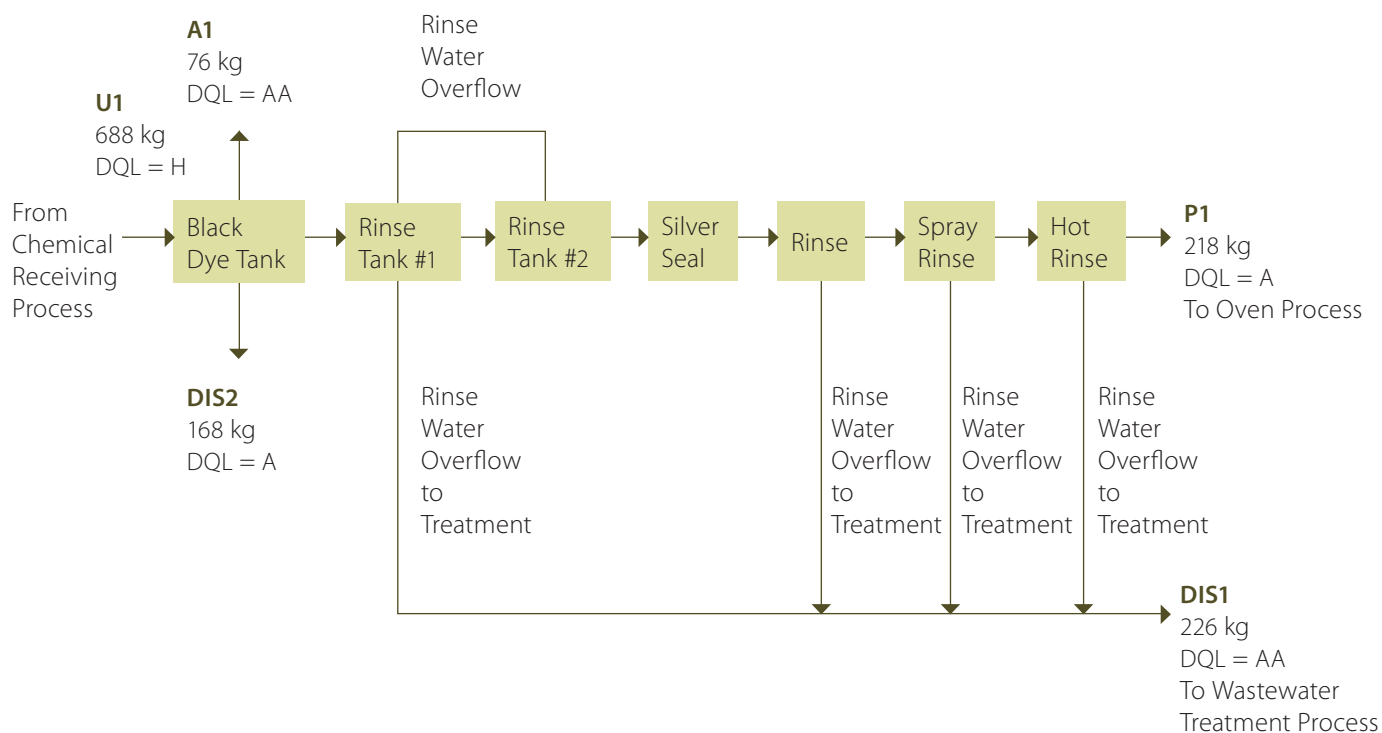
into another prescribed toxic substance or is it destroyed? Under what conditions do these occur?

- What happens to it after it leaves the process? Does it go to another process or does it leave the facility?

Figure 7 provides an example for a fictional anodizing facility and describes the process both with text and a visual representation that shows the movement of chromium for the black dye process.

Figure 8 illustrates a process flow diagram example that shows the use, transformation, and destruction of a prescribed toxic substance. This process flow diagram depicts the ore extraction process associated with a fictional gold mining operation. The substance being tracked is ionic cyanide.

Figure 7: Process Flow Diagram for Black Dye Process Involving Chromium



Legend

- Solid arrow denotes **presence** of toxic substance
- U** **Use** of toxic substance
- P** Toxic substance **Contained in Product**
- A** **On-site release** of toxic substance to **AIR**
- DIS** **On-site** or **Off-site Disposal** of toxic substance
- ### kg** **Quantification** of toxic substance
- DQL** Data Quality Level = **H** "High"
AA "Above-Average"
A "Average"
U "Uncertain"
- A process where chromium is present

Figure 7 Description:

Chromium is added to the black dye tank from the chemical receiving process (**U1**). Parts are dipped in the black dye tank in order to give the surface of the part the desired colour and finish. The black dye process involves immersion of parts in this bath, which is a solution containing a trivalent chromium metallized azo dye. A chemical reaction occurs in the bath, and some chromium is deposited on the surface of the parts in the tank. This amount of chromium is now embedded as a surface coating on the part, and it will end up in the final product – passing through the following processes without loss or transformation.

Note that the parts are hung on racks, and the operator uses a hydraulic system to lift the racks of parts out of each tank and move it to the next tank for immersion. The parts on the racks typically carry some liquid from each bath into the following bath, which is termed “drag-out” from the preceding bath and “drag-in” to the next bath. Thus, some chromium is “dragged” out of the black dye tank and into the following rinse tank #1. Another portion of chromium is also dragged out of rinse tank #1 and into rinse tank #2, but this is a lesser amount since the concentration of the chromium in the tank #1 is much lower than in the black dye process tank. Rinse water overflow from rinse tank #2 is routed back to rinse tank #1. There is also some drag-out of chromium from rinse tank #2 into the following tank, containing a silver seal product, and then into the following tanks, which are additional rinse tanks. The parts are then transferred to the oven process (**P1**). Each of the rinse tanks that overflow to the wastewater treatment system potentially carry some chromium from the baths to the wastewater treatment process (**DIS1**).

The black dye tank requires periodic replenishing of the ingredients in the black dye solution. The operator does a quality control check once per shift, and adds a required amount of black dye powder to maintain the bath concentration at a level of 15 g/L. In addition, once per year the entire bath contents are changed, due to the accumulation of contaminants in the bath, and the tank contents are disposed of off-site as hazardous waste by a licenced contractor (**DIS2**).

There is a ventilation system above the black dye tank, and some chromium is lost to the atmosphere as an air emission (**A1**).

Figure 8: Gold Extraction Process Flow Diagram Involving Ionic Cyanide, including Use, Transformation and Destruction

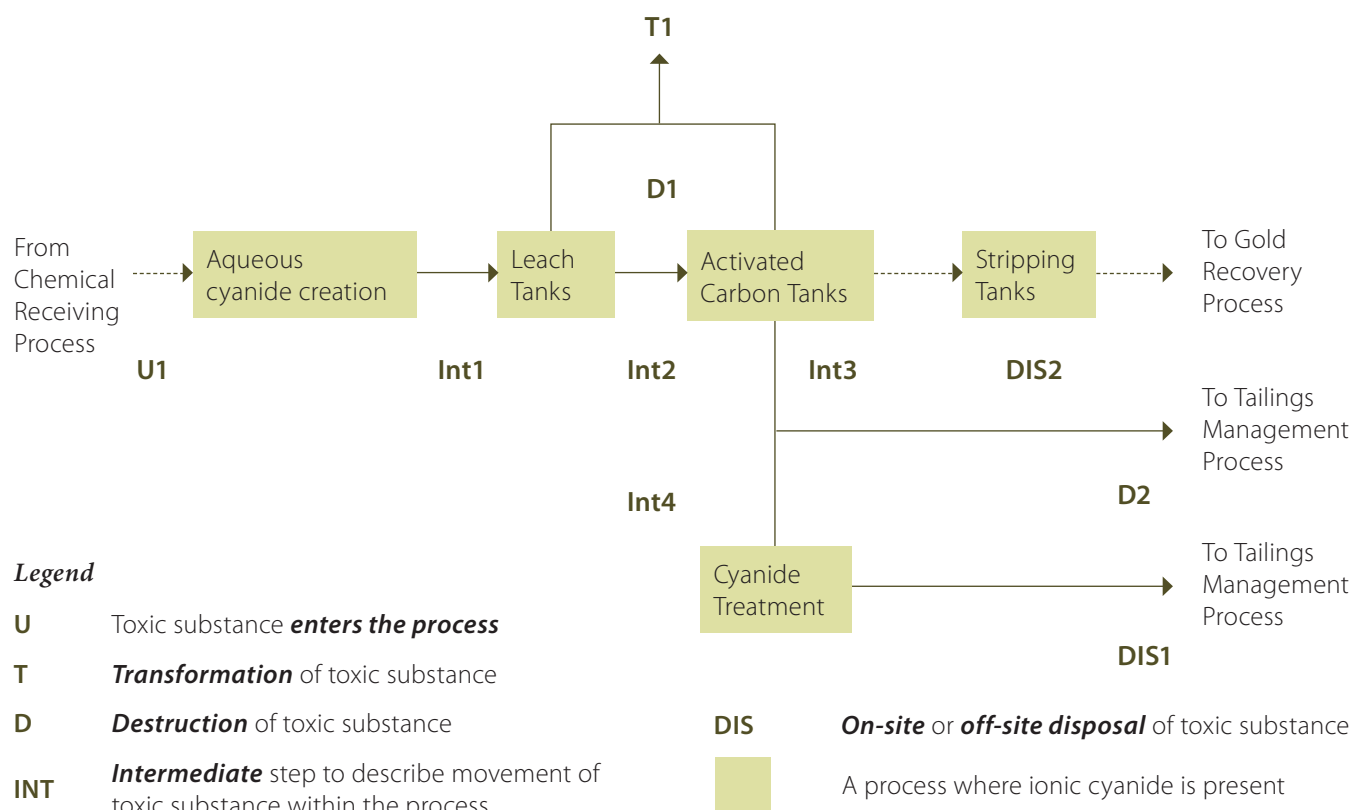


Figure 8 Description:

Cyanide salt (ionic) is added to water to create an aqueous ionic cyanide in a solution (**U1**). This ionic cyanide solution is added to the raw ore slurry leach tanks. Some of the ionic cyanide bonds with the gold to form aurocyanide in solution. The ionic cyanide that bonds with gold to form aurocyanide is considered to be destroyed. The slurry mixture coming out of the leach tanks (containing water, ground ore, ionic cyanide and aurocyanide (**D1**)) is transferred to activated carbon tanks, where the aurocyanide is adsorbed onto the activated carbon. The slurry in the leach tanks and activated carbon tanks is maintained at a pH of greater than 12 by adding lime to the tanks. This largely avoids the transformation of ionic cyanide to hydrogen cyanide that is released to the air from these activities (**T1**) (although by nature of the chemical reaction, it is less likely to have zero releases of

hydrogen cyanide; however, reducing these releases to less than 1% is possible). The gold-loaded carbon from the activated carbon tanks is then transferred to stripping vessels where the gold is removed from the carbon into a solution. The gold solution is then transferred to the recovery process. The spent ore slurry containing the remaining ionic cyanide from the activated carbon tanks (**Int3**) is routed to a cyanide treatment area during the coldest six months of 2010 (**Int4**). In the cyanide treatment area, most of the ionic cyanide is destroyed by being converted into cyanate (**D2**). The treated spent ore slurry, containing the destroyed cyanide along with a small quantity of untreated ionic cyanide, is transferred to the tailings management process (**DIS1**). During the warmest six months of 2010, the spent ore slurry from the activated carbon tanks was transferred directly to the tailings management process, bypassing the cyanide treatment area (**DIS2**).

4.3.1. How a Substance Enters the Process

After identifying which processes use and/or create a prescribed toxic substance, an owner and operator must determine how it enters the process at the facility (as the substance itself or as a constituent of another substance).

It is also important to consider whether the substance enters intentionally or un-intentionally.

Some examples of how a substance may enter a process include:

- The arrival of purchased materials containing the substance in the storage process for later use;
- Hexavalent chromium used in the hard chrome plating tank to be consumed in the chromium plating process;
- The use of zinc in the hot dip tank in the production of galvanized steels;
- The use of hydrochloric, hydrofluoric, and sulfuric acid in the mineral processing activities to extract a metal from ore;
- The use of chromium and nickel alloy to be used for manufacturing of stainless steel;
- Ionic cyanide, as a constituent of wastewater, which enters a cyanide treatment process;
- Chromium and nickel as constituents (alloying elements) of a metallic industrial part (e.g. a semi finished product made by stainless steel) enters a process to receive a ceramic coating.

4.3.2 Creation of Toxic Substance(s)

After identifying which processes use and/or create a prescribed toxic substance, the next step is describing how it is created in the process (whether intentionally or unintentionally).

The “Stability and Reactivity” and “Toxicological Information” sections of a WHMIS controlled-product’s MSDS may provide information on

the substances that may be created through normal use of the product or that may be created under special conditions (such as temperature or pressure or mixing with other substances). In the absence of this data, a facility is encouraged to investigate operations that involve the mixing of chemicals, pressure, and temperature to determine whether any new prescribed toxic substances are created. Examples of prescribed toxic substances that may be created include:

- Nitrate compounds formed in wastewater as a result of wastewater treatment operations;
- Hydrochloric, hydrofluoric, and sulfuric acids formed by combustion of coal, raw materials for brick manufacturing;
- Organic compounds including polycyclic aromatic hydrocarbons (PAHs), such as benzo(a)pyrene formed by combustion of fuel sources such as wood and hydrocarbons;
- Dioxins and furans as a result of smelting;
- Styrene formed through the thermoforming of polystyrene;
- Acetaldehyde formed through the extrusion of polystyrene;
- Creation of ammonia during curing operations;
- Creation of formaldehyde during painting operations;
- Diisocyanates or toluene diisocyanates formed from the chemical reaction of mixing specialty paints;
- Creation of acids or ionic substances (such as cyanides) when their salts are added to an aqueous solution.

The EPA Sector Notebooks provide additional examples of where prescribed toxic substances are created. These notebooks are available online (as of July 2010) at: <http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/>.

4.3.3 Transformation of Toxic Substances

After identifying which processes use and/or create a prescribed toxic substance, an owner and operator must determine if it is transformed into one or more other prescribed toxic substances.

The “Stability and Reactivity” and “Toxicological Information” sections of a WHMIS controlled-product’s MSDS may provide information on prescribed toxic substances that may be transformed through normal use of the product or that may be transformed under special conditions (such as temperature or pressure or mixing with other substances). In the absence of this data, a facility is encouraged to investigate operations that involved the mixing of chemicals, pressure, and temperature to determine whether prescribed toxic substances are transformed into other prescribed toxic substances. A couple of examples of prescribed toxic substances that may be transformed include:

- Fluorine to hydrogen fluoride as a result of combustion;
- Ionic cyanides to hydrogen cyanide under certain conditions (i.e. pH).

It may be important to understand how and under what conditions transformation occurs. An enhanced understanding of the complex chemistry of a particular process and the response of the process to variables that can be controlled may often result in the identification of options to reduce or eliminate the creation on unwanted by-products.

4.3.4 Destruction of Toxic Substances

After identifying which processes use and/or create a prescribed toxic substance, an owner and operator must determine whether the substance was destroyed. If the substance changes into one or more substances that are

not prescribed toxic substances it is considered destroyed under the Act and regulation. This is different than transformation which takes place when a prescribed toxic substance is transformed to another substance that is also prescribed under the regulation.

Examples of destruction include:

- Bonding of an ionic substance (such as cyanides) to another substance to create a more stable molecule (for example, the bonding of ionic cyanide with gold in order to extract gold from ore creates aurocyanide, which is not a prescribed toxic substance)
- On-site treatment of prescribed toxic substances to create substances that are not toxic (for example, the treatment of cyanide to produce cyanates)
- Degradation of prescribed toxic substances into substances that are no longer toxic (for example, cyanide has the ability to naturally degrade into other substances such as cyanates)

4.3.5 Toxic Substance(s) Contained in Product

After identifying which processes use and/or create a prescribed toxic substance, an owner and operator must determine whether the substance leaves the process as contained in product. At the process level, contained in product does not necessarily mean the final product intended for sale. It may also apply to products that are temporary and needed further along in the manufacturing operation.

Examples of substances contained in product leaving a process include:

- The raw materials containing the substance leaving storage to be used in a manufacturing operation or mineral processing;

- When extracting and concentrating copper from an ore, the **sulfuric acid** leaving with the dissolved copper from one of the purification processes;
- The ethylbenzene in varnish or paints that has been manufactured at the facility that is intended for distribution or sale.

4.3.6 Intermediate

The term “intermediate” may be useful to describe a circumstance when a prescribed toxic substance moves through a process that is not sufficiently covered by any of the other terms provided. This is not in the regulation and it is up to the facility to decide whether it is a useful approach for use in their process flow diagrams.

5.0 Choosing Methods for Tracking and Quantification

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The Regulation requires that:

"...A record that describes the method or combination of methods used to track and quantify the substance in each process and explains why the method or combination of methods was chosen."

(O. Reg. 455/09, s. 12 (2) 5)

The Regulation also requires that:

"...the best available method or combination of methods for tracking and quantifying the toxic substance is used, taking the following into consideration:

- 1. How the substance enters the process, what happens to it during the process, how it leaves the process and what happens to it after it leaves the process.*
- 2. Industry standards.*
- 3. Economic achievability of a method or combination of methods.*
- 4. Continuous monitoring, predictive monitoring, source testing or sampling, mass balance, published emission factors, site-specific emission factors and engineering estimates.*
- 5. Any methods required to be used for the purposes of meeting a requirement under federal, provincial or municipal law."*

(O. Reg. 455/09, s. 12 (6))

The regulation requires that the amount of a substance that enters the process, is created, transformed, destroyed, contained in product, disposed, released to the environment, or transferred for recycling is tracked and quantified using the best method or combination of methods available to that facility and also

requires that a rationale for determining the best available method be provided in a record.

5.1 Determining Best Available Methods

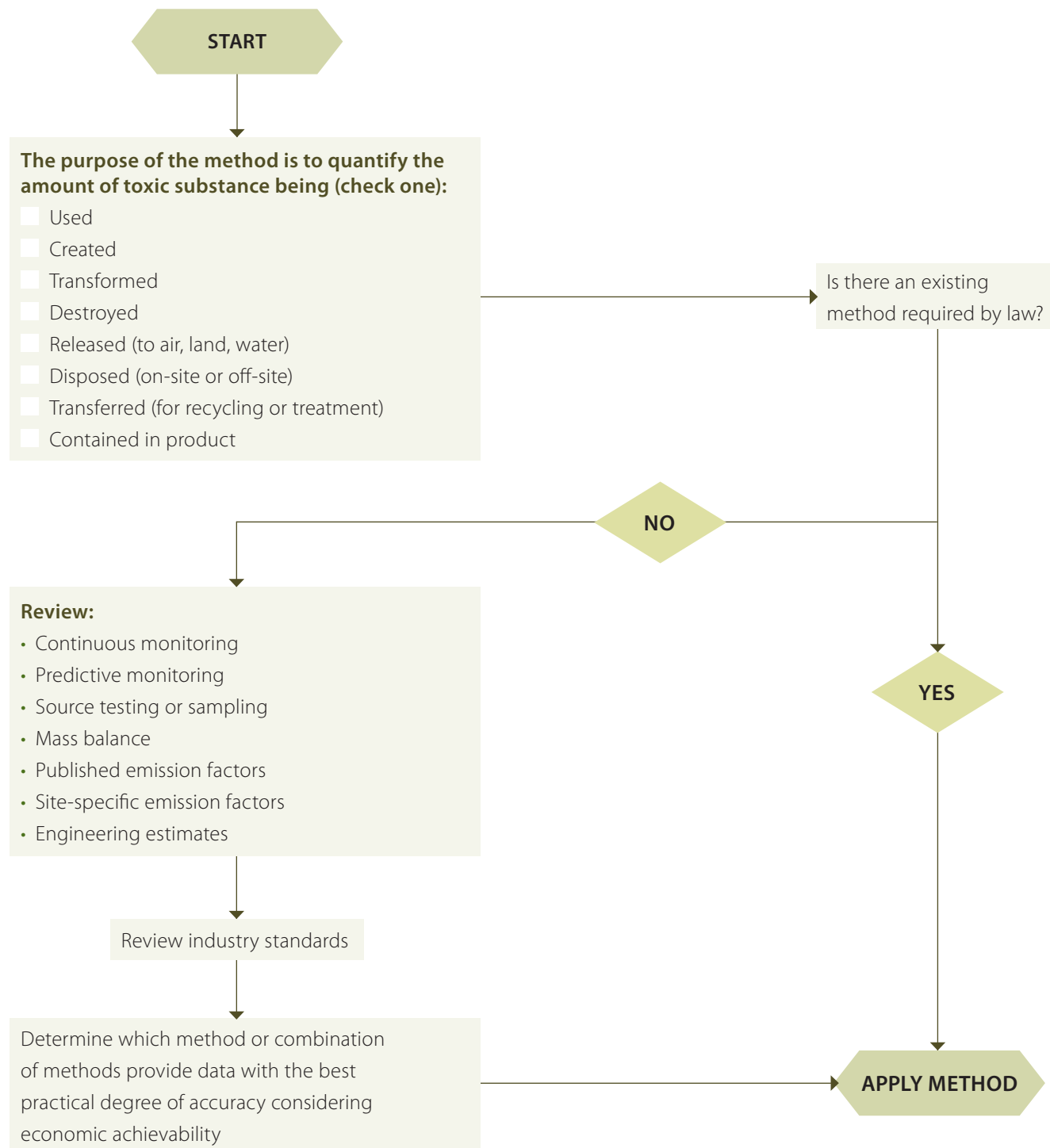
The reason for including the concept of **Best Available Methods** in the regulation is to convey the importance of data quality generated by the methods chosen and to provide decision making information when determining which toxics reduction options, if any, are worthwhile to implement. The best quality data should be balanced with the considerations set out in regulation, such as existing practices based on industry standards, economic realities, and applicable laws that prescribe methods. Subsections 5.1.1 to 5.1.9 of this toolkit provide some discussion for each of the aforementioned considerations.

Figure 9 illustrates a decision making approach that may assist a facility in evaluating and selecting a best available method.

The following questions may help a facility to understand the considerations specified in the regulation:

1. What is the method quantifying (use, creation, etc)? What form is the prescribed toxic substance in?
2. Is there current methodology prescribed by law for measuring the amount of a prescribed toxic substance in the pathway or route?
3. If no method is prescribed by law, the owner and operator may consider a number of methods including: continuous monitoring, predictive monitoring, source testing or sampling, mass balance, published emission factors, site-specific emission factors and engineering estimates.

Figure 9: Possible Decision Making Process to help Determine Best Available Method



4. When considering a direct measurement methodology (such as continuous monitoring, source testing or sampling), consider the following:
 - Is there a standard sampling methodology that has been proven to yield reliable results for the prescribed toxic substance and the pathway or route requiring sampling?
 - Does the facility have the ability to design and implement a sampling program that will yield results that are representative of the pathway or route requiring quantification? This will be dependent upon access to a sampling point, homogeneity of the stream being sampled, the number of samples required, and the cost to collect and analyze samples for the prescribed toxic substance.
5. Are there industry standards for methods? And are there sector specific engineering estimates for quantifying the amount of the prescribed toxic substance?
6. What is economically achievable for the facility? Consider the following:
 - What is the cost associated with obtaining the data and implementing the method or combination of methods?
 - Does a more costly method result in a significantly better data quality level than the next best method (consider the economic achievability of the two methods)?
 - Are there other benefits to having data with a higher degree of accuracy - such as from a business or environmental stewardship perspective?

- What data accuracy is needed for decision makers to make the decision to implement a toxic substance reduction option?

5.1.1 Industry Standards

Industry standards are generally understood to be industry-developed practices that become commonly accepted norms of business practice. Facilities may find it useful to look toward industry developed guidance documents and/or training materials for methodologies of measuring quantities of substances in different processes. These materials may be found through industry associations, trade journals, conference presentations, and potentially developed by the facility itself.

There are a number of sector specific guidance documents, documents on best practices and best management practices, as well as other resources that describe typical processes associated with a given sector, substances used and created, along with their fate. These resources may include quantifications (on transfer rates, emission factors, amount of prescribed toxic substance contained in product) developed from tests performed at a facility within a particular industry, considered to be representative of the industry as a whole and operation tested. For some sectors, there may be numerous published or commonly accepted methods of measuring quantities of substances in different processes that have been developed by industry. In the context of best available methods, the facilities are encouraged to consider the methods that will yield good quality data for their particular facility.

5.1.2 Continuous Monitoring Method

Continuous monitoring is a direct measurement system that records data over an extended and uninterrupted period of time. Once the concentration and the flow rate have been determined, quantification can be accomplished by multiplying the concentration by the flow rate and the length of time in operation. Continuous monitoring is typically used for process water, and air emissions. The benefits of continuous monitoring are that it may provide an accurate representation of concentrations of prescribed toxic substance inputs, transfers and releases. Differences resulting from different batch processes during different shifts or commingling of streams throughout the day, and changes in process parameters, such as temperature, operator input, are all accounted for. Continuous monitoring systems also allow for quantification of streams attributed to non-normal, maintenance, cleaning, or upset conditions. Significant effort may be required to interpret results to determine whether, for quantification purposes, an average annual concentration multiplied by the number of hours of operation would provide a reasonable representation of total mass, considering the number, frequency and impact of non-normal, maintenance, cleaning, and upset conditions/operations.

Continuous emission monitoring is considered to be a higher cost estimation method.

5.1.3 Predictive Monitoring Method

Predictive monitoring is based on developing a correlation between prescribed toxic substance creation, transformation, destruction or adherence to product and process parameters such as fuel usage, raw material input, and oven

temperature. Predictive monitoring may be considered a hybrid of continuous monitoring and source testing. A correlation test must first be performed to determine the relationship between prescribed toxic substance creation, transformation, destruction, adherence to product or release and process parameters. For example, a facility (or industry association) may undertake a test or series of tests to determine the amount of a prescribed toxic substance that is released during curing based on the temperature of the oven and how much of a substance adheres to the product. A chart or graph is normally created. A facility may then monitor oven temperatures (a simple and cost effective parameter to measure) and then using the chart determine the amount of the prescribed toxic substance that is contained in product. Quantifications can then be calculated or predicted using process parameters based on the results of the initial correlation test.

5.1.4 Source Testing or Sampling Method

Source testing involves direct measurement of the input, output, or product streams to determine the concentration of a prescribed toxic substance in a sample or stream. The concentration of the toxic substance is then multiplied by the flow rate and time or by the volume to quantify the amount of the prescribed toxic substance for the year. Source testing of air streams generally involves inserting a sampling probe into a stack or duct to collect a volume of exhaust effluent isokinetically. Source testing of air streams may also include drawing a known volume of air through a pump or tube, as for industrial hygiene sampling. The contaminants collected in or on various media are subsequently analyzed. For liquid or solid streams, grab

samples or 24-hour composite samples are extracted from the targeted stream. Sampling of product may involve composite of discrete sampling and testing. Judgment is required to determine how to deal with sample results that are below detection limits.

The benefits of source testing are that it can provide an actual concentration of a prescribed toxic substance contained within the targeted stream from a discrete source. However, this data is rarely available to characterize each stream and testing results often represent a “snap-shot” in-time. For batch processes with relatively consistent inputs, source testing is a very accurate means of quantification. However, this would need to be verified by collecting samples from different batch processes during different shifts, and for various process parameters, such as temperature and operator input. Judgment is required to determine an appropriate sampling plan that would provide data representative of the operation/process over a year.

When a manufacturing product is a WHMIS controlled product in Canada or is destined for export to a location with strict requirements, source testing may be a regulatory requirement for the end product. It may also be required to demonstrate compliance with customer specifications.

Source testing is often conducted as a regulatory requirement for provincial or municipal authorities. Under the Municipal Industrial Strategy for Abatement (MISA) *Effluent Monitoring and Effluent Limits* regulations, industrial dischargers are required to sample their wastewater discharge, analyze the wastewater discharge samples, and report data based on the results of the analysis of the

samples, as well as to ensure that the quality and quantity of wastewater discharge comply with regulatory limits. The Ontario Ministry of Environment document, “Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater” provides guidance on sample types and techniques for grab samples, composite samples, on-line analyzers, automated sampler considerations, and compositing techniques.

Few municipal sewer-use by-laws require effluent sampling. However, municipalities often collect effluent samples downstream of or at industrial facilities to assess compliance with sewer use limits. This data may be available to the facility upon request.

Certificates of Approval (Industrial Sewage Works) often contain conditions that require Certificate holders to sample their discharge, analyze the discharge samples, and report data based on the results of the analysis of the samples.

Source testing for air emissions is not a common condition of Certificates of Approval (Air). However, during the application process the Ministry may require source testing to support engineering estimates. In these cases the source testing methodology may be prescribed or may need to be approved prior to testing.

Source testing of waste streams is routinely undertaken by the waste receiver prior to acceptance of the waste and on a random and set frequency to confirm that the waste treatment facility can accept the material. Such analytical data is available to the generating facility.

5.1.5 Published Emission Factors Method

Emission factors are typically constants (usually expressed in mass emission per unit of production or mass of raw material input) which are applied to a process parameter or production rate to generate an emission rate. The most commonly used emission factors are those published by the United States Environmental Protection Agency (US EPA). The US EPA, other regulatory agencies, and industry associations use data from past source testing performed at one or more facilities within a specific subsector to develop emission factors for a variety of industrial processes. These emission factors may provide reasonable assumptions of concentrations of prescribed toxic substances emitted/released when they are applied to a source that they were meant for.

The basic equations for determining emissions from emission factors are as follows:

$$Ex = BQ \times CEFx$$

or

$$Ex = BQ \times EFx \times (100 - CEx)/100$$

Where:

Ex = Emission of contaminant x in kg (or other unit of mass)

BQ = Activity rate or base quantity (BQ), base quantity unit

CEFx = Controlled emission factors of contaminant x, in kg/BQ (value is dependent on the external control devices installed, if any)

EFx = Uncontrolled emission factors of contaminant x, in kg/BQ

CEx = Overall emission control efficiency of contaminant x, %

The following sources of emission factors are commonly used and widely available:

- Emission Factors published in the US EPA Document Number AP-42 (www.epa.gov/ttn), Compilation of Air Pollutant Emission Factors. This document includes process descriptions and emission factors for a broad range of criteria contaminant emission sources. Supplements are published regularly.
- Factor Information Retrieval (FIRE) Data System; www.epa.gov/ttn/chief/software/fire/index.html. The FIRE Data System (from the US EPA) is a database that may be used in initial efforts to identify contaminants. Note: although the FIRE Data system may be used to identify contaminants from a variety of sources, the quality of the emission factors listed in this system varies.
- Locating and Estimating (L&E) documents for specific prescribed toxic substances (see www.epa.gov/ttn/chief). The L&E report series are for specific air emissions from sources (source category or substance) and characterizes the source categories for which emissions of a prescribed toxic substance have been identified. These volumes include general descriptions of the emitting processes, identifying potential release points and emission factors. The L&E series presently contains emission reports for prescribed toxic substances such as Acrylonitrile, Arsenic, Benzene, 1,3 Butadiene, Cadmium, Carbon Tetrachloride, Chlorobenzene, Chloroform, Chromium, Cyanide, Dioxins and Furans, Formaldehyde, Lead, Mercury, Methyl Chloroform, Methyl Ethyl Ketone, Methylene Chloride, Nickel, Perchloroethylene, Styrene, Toluene, and Xylene.
- U.S. state environmental agencies also publish information such as the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Officials (ALAPCO) (www.cleanairworld.org/).

- Guidance and emission rate estimating information provided by the Ontario Ministry of Environment for Regulation 127/01 – Airborne Contaminant Discharge Monitoring and Reporting (see <http://www.ene.gov.on.ca/envision/monitoring/monitoring.htm>) and provided by Environment Canada for reporting to the National Pollutant Release Inventory (see www.ec.gc.ca/pdb/npri/npri_home_e.cfm).
- Contaminants identified from site-specific source testing and/or industry sponsored studies.

5.1.6 Site-specific Emission Factors Method

Industrial facilities may also develop their own site-specific emission factors using emission-testing data and source activity information. For a particular piece of equipment, specified emission factors may be available from the manufacturer. It is cautioned though that facilities only rely on equipment specified emission factors if the equipment is used for the application intended and is operated and maintained in accordance with the specifications and manufacturers' operating and maintenance manuals.

5.1.7 Engineering Estimates Method

In many cases, engineering assessments are the most appropriate approach to determining process factors and base quantity values. Concentrations of prescribed toxic substances in various targeted streams may be estimated from engineering principles and judgment, by using knowledge of the chemical and physical processes involved, the design features of the source and an understanding of the applicable physical and chemical laws. The reliability of these estimates depends on the complexity of

the process and the level of understanding of its physical-chemical properties. The best practice to applying engineering estimates may include the following basic principles:

- Review data pertaining to the specific source and to the industrial sector in general;
- Use the data to provide gross approximations and refine them using sound engineering principles as data becomes available to provide more accurate estimations;
- Whenever possible, alternate methods of calculation should be followed to cross-check each level of approximation;
- Employ good record keeping by documenting all related information for further emission refinement when more accurate data becomes available.

The use of derived formulae (sometimes in combination with accepted empirical data) is also considered an engineering estimate.

The following provides an example of an engineering estimate for determining toluene emissions from a solvent waste storage tank during filling operations:

Assumptions:

The volume of vapour emitted when filling a waste tank will be the same as the volumetric flow rate of the liquid entering the tank as long as the liquid entering the tank is not under pressure.

A typical truck pump has a volumetric flow rate of 50 US Gallons per minute (190L/min)

The concentration of a contaminant in the vapour phase is proportional to the mole fraction of that contaminant in the liquid times its vapour pressure (Raoult's Law).

Assume the facility empties the waste tank at 50 US Gallons/min (190 L/min) to the truck. Since the vapour emission rate is the same as the liquid transfer rate, the emission from the waste tank vent is 50 US Gallons per minute (3.15 L/s) of saturated vapour at 20 °C (293.15 K) and atmospheric conditions. This temperature is generally higher than expected in an external tank in Ontario (even in the summer) but the saturated vapour pressure is generally published at 20 °C or 25 °C so the emission calculated may be conservatively high.

Assume the liquid in the waste tank has the following composition:

- Saturated vapour pressure for toluene is 22.4(mmHg)
- Molecular weight of toluene is 92.13(g/g-mole)
- Weight % Composition (Mass basis) is 65% (from analytical testing results)

If 1 kg of solvent is used as a base, the moles of each contaminant is calculated as:

Moles Toluene /kg Solvent = "Weight % Composition" / "Molecular Weight". So, Moles of Toluene/kg of Solvent = 0.007055 kg-moles

The liquid phase mole fraction (F) = moles of contaminant in liquid phase/ total moles in liquid phase so the liquid phase mole fraction for toluene is 0.007055 / 0.01144 = 0.62.

For an ideal gas, the Ideal Gas Law says $PV=nRT$

Where:

P = Pressure of the gas (101.3 kPa at atmospheric pressure)

V = Volume of gas (in L)

n = moles of gas (in g-mol)

R = 8.314 kPa L/g-mol K

T = Temperature (in Kelvin)

And, $n = M/Mwt$

Where:

n = moles of gas (in g-mol)

M = mass of gas (in g)

Mwt = molecular weight of the contaminant (in g/g-mol)

So the mass emission rate of toluene from the tank is $M = MwtPV/RT = 0.2195 \text{ g/s}$.

Note: This example is derived from the Ministry of Environment's "Ontario Air and Noise Best Practices" document for Vapour Emissions from a Solvent Waste Storage Tank.

5.1.8 Mass Balance Method

Using a mass balance method involves applying the law of conservation of mass to a process or piece of equipment. If there is no accumulation, then all the materials that go into the activity or process must come out. Releases are determined from the differences in input, output, accumulation and depletion of a substance. The general equation for a mass balance is:

$M_{in} = M_{out} + M_{accumulated/depleted}$

Where:

M_{in} = Mass of compound in the raw material feed + mass created

M_{out} = Mass of compound in the finished product and released to air, land and water

$(M_{out} = M_{product} + M_{emitted})$

M accumulated/depleted = Mass of compound
accumulated
or depleted in
the system

The reliability of quantifications based on mass balances is dependent on the source type considered. In general the mass balance method may be appropriate for some quantifications, such as solvent use and transfers. However, this method may not be suitable for many other sources, such as cases where chemical transformation of input streams occurs. Field verification of material usages may be recommended for these cases.

5.2 Feedstock

It is recognized that raw materials such as ore, coal, crude oil or trees, pose a challenge to facilities in tracking and quantifying substances that are entering relevant processes. These raw materials derived from resource based operations are called feedstock materials. While the regulation requires tracking and quantification of prescribed toxic substances in processes (which may include feedstock materials) the regulation does not prescribe any specific method, only that it is the best available method or combination of methods. Best available methods may include a combination of analytical testing results and industry best practices.

For example, the pulp and paper industry, NCASI and Forest Product Innovation Centre (FPIC) maintain (member access only) databases that provide standard concentrations of various NPRI substances by species of tree, or by type of recycled material used as feedstock. The FPIC has data that is more applicable to Canadian or regional feedstock sources as it incorporates the influence of Canadian soil bases into the values (i.e. Canadian shield).

One source for estimating concentrations of substances in ore feedstock could come from an individual facility's assay results (in addition to other testing methods, depending upon the type of mining) which would provide the average fractions of a limited suite of parameters in feedstock. However, not all of the listed prescribed toxic substances that may be contained in the ore will be tested. For example, some metals are commonly found together, so this will influence what gets tested when characterizing a vein.

For the petroleum industry, the Chemistry Industry Association of Canada, has commissioned several studies on best practices for calculating releases of volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene and xylene from the management of feedstock materials.

The US Agency for Toxic Substances and Disease Registry (ATSDR) may also provide information on the concentration of prescribed toxic substances in raw materials derived from petroleum products.

5.3 Assigning a Quality Level to Data Quantification Methods

This section of the toolkit provides some discussion regarding the quality of data that certain methods produce versus others. It should not be interpreted as the ministry requiring or preferring one method over another, but rather as simply providing an approach to assigning a data quality level classification system.

“Highest” Data Quality Level Quantification Methods

- Continuous monitoring of prescribed toxic substances, according to an approach that has been validated by a regulatory agency.
- Comprehensive and validated source testing over a range of operating conditions.
- Quantifications that are derived from comprehensive equipment-specific testing (e.g., source tests are conducted to measure a prescribed toxic substance contained in targeted stream over a range of operating conditions where process data was available and recorded; and result in a statistically significant data set).
- Mass balance for processes where:
 - » 100% of the material balance is accounted for (e.g., 100% emitted to air as may be the case for some highly volatile prescribed toxic substances); and
 - » is reasonable to assume that the prescribed toxic substance will not undergo a chemical transformation through the source/process.

“Above-Average” Data Quality Level Quantification Methods

- Validated source testing at one specific operating condition.

- Quantifications that are developed from tests on a moderate to large number of industry sources where the source category population is sufficiently specific to minimize variability.
- Engineering calculations/judgment: Quantifications derived from fundamental scientific and engineering principles.

“Average” Data Quality Level Estimating Quantification Methods

- Quantifications that are developed from tests on a reasonable number of facilities where the source category population is sufficiently specific to minimize variability.
- Engineering calculations/judgment: Quantifications derived from fundamental scientific and engineering principles and/or relevant empirical data.
- Partially validated source testing at one specific operating condition: emission rate estimates that are from source testing where the testing has only been partially validated at a specific operating condition.

“Marginal” or “Uncertain” Data Quality Level Quantification Methods

- Un-validated source testing at one specific operating condition: emission rate estimates that are from un-validated source testing.
- Quantifications that are developed from tests on only a small number of facilities where there is evidence of variability within the source category population
- Calculations/judgment: Quantifications derived from calculations where the scientific/technical integrity of the approach is uncertain are considered to have uncertain data quality.

5.4 Describing Methods

The Regulation requires that:

"...A record that describes the method or combination of methods used to track and quantify the substance in each process and explains why the method or combination of methods was chosen."

(O. Reg. 455/09, s. 12 (2) 5)

The purpose of the requirement to describe the method or combination of methods is to:

- Provide details on the decision making process for choosing the best available method at the current time and share it with other people at the facility for future years;
- Provide contextual information on the numbers generated by the method(s) chosen; and
- When applicable, determine if a change in the method(s) is(are) warranted. Please note that there is further discussion on when it is appropriate to change the method(s) in section 5.5 of the toolkit.

5.5 Maintaining Consistency in Tracking and Quantification Methods

The Regulation requires that:

"The method or combination of methods used for tracking and quantifying a toxic substance for a process shall not be changed unless,

(a) the change is as a result of a review of the current version of the toxic substance reduction plan for the substance under section 7 of the Act; or

(b) the change is for the purposes of complying with a requirement under an Act, an Act of Canada or a municipal by-law."

(c) subject to subsection (7.1), the change,

(i) is made as a result of a recommendation provided by a toxic substance reduction planner under section 18.2, and

(ii) is made after the recommendation is provided and before June 1 in the year immediately following the year in which the recommendation was required to be obtained.

(7.1) Clause (7) (c) does not apply if the recommendation is provided in respect of a new version of a plan prepared as a result of an amendment under section 5 of the Act.

(O. Reg. 455/09, s. 12 (7))

"If the method or combination of methods for tracking and quantifying a toxic substance is changed under subsection (7), the record created under paragraph 5 of subsection (2) shall be amended to describe the new method or combination of methods and the owner and the operator of the facility shall ensure that the change is reflected in the next version of the toxic substance reduction plan."

(O. Reg. 455/09, s. 12 (8))

The regulation requires that once a facility decides upon the best available method or combination of methods, it must continue to use the method(s) until the toxic substance reduction plan is reviewed. Generally this occurs once every five years, starting in 2018. However, if required by another law, a method may be changed in between the review periods. The rationale behind requiring that the method remains consistent is based on the overall objective of the Strategy, to show trends and comparisons from one year to the next. If changes in the quantifications occur due to a change in methodology, it would be difficult for a facility

to demonstrate that the change occurred due to actions resulting from implementation of an option in the toxic substance reduction plan.

For clarification purposes, a change in methodology refers to a change from one method listed in the regulation to another (continuous monitoring, predictive monitoring, source testing or sampling, mass balance, published emission factors, site-specific emission factors and engineering estimates). For example, from engineering estimates to mass balance or from one combination of methods to another.

A facility may update or improve an existing methodology that it has been using. For example,

if a facility has been using published emissions factors and there is a newly published update, the facility may use the updated value without it being considered a change in method.

This above clarification may help address some concerns that facilities may have with regard to ensuring that they are meeting the spirit of NPRI. NPRI guidance encourages facilities to use better methods as they become available. While NPRI does not prescribe the continued use of a methodology listed in its Gazette notice, Ontario Regulation 455/09 requires the continued use of a method(s).

Figure 10: Example – Considerations in Determining the Best Available Method or Combination of Methods for Tracking and Quantification of Chromium Contained in Product

Process	Method/ Combination of Methods	Industry Standards	Economic Achievability	Considerations
Electroplating: Decorative chromium plating	Engineering estimate*	Estimation based on process parameters, engineering principles, pilot testing, data from process texts	Cost for facility internal resources or external consultants	Time and chromium thickness conversion data/chart for reliable process parameters need to be prepared; published reports to be assessed for applicability Average data quality
	Predictive monitoring*	Includes process time measurement; determining electroplating time for specific products based on real time data, electroplating constants, equipment specifications, conversion charts and modeling	Costs for analysis of existing process data and to determine correlation	Time and chromium thickness conversion data/chart for reliable process parameters need to be prepared Average data quality

Process	Method/ Combination of Methods	Industry Standards	Economic Achievability	Considerations
Electroplating: Decorative chromium plating	Continuous monitoring	Coating thickness gauges: Magnetic Induction or XRF (X-Ray Fluorescence Spectrometry)	Significant equipment cost involved to purchase thickness gauge(s); sample preparation costs	Some thickness interference limitations for XRF monitoring Highest data quality
	Mass balance*	No industry standard for precise measurement of mass in-mass out	Costs for scale	May be feasible for smaller parts
	Source testing/ Sampling	Metallographic evaluation: cutting/ lathing, preparing and observing by microscope	Equipment for sample preparation and optical microscope/costs	Sample preparation time Determination of representative number of samples per product Above-average data quality
	Site-specific emission factor/ Published emission factor	Not Applicable	Not Applicable	Not Applicable

Note: There is no existing methodology required by law for quantification of chromium contained in product. For this process, chromium is contained in the coating on the product leaving the process. Quantification includes the determination of the amount of chromium in the coating and the amount of coating on product (surface areas and thickness).

In this example, the best available methods for quantification of chromium in produce would be a combination of **Engineering estimate and Predictive monitoring along with** one of the following methods: **Mass balance** (for small to medium products), or **continuous monitoring** (for big or complex products), or **Sampling**.

6.0 Tracking and Quantification

6.1 Analysis – Input / Output Balances

53

After a facility has identified in the process flow diagrams how the substance moves through each process, the next step is to track and quantify (i.e. toxic substance accounting). This section of the toolkit provides some suggestions as to how a facility might meet these requirements.

The Regulation requires that:

"... the owner and the operator of a facility shall create the following records in respect of the toxic substance..."

3. A record of the tracking and quantification of the substance for each calendar year in which section 9 of the Act applies in respect of the substance."

(O. Reg. 455/09, s. 12 (2) 3)

The Regulation also states that:

Section 9 of the Act does not apply in respect of amounts of a toxic substance that enter a process or are created, destroyed, transformed, released, disposed of, transferred or contained in product, if, under the NPRI Notice, the amounts are excluded from the determination of whether the criteria for reporting under the NPRI Notice are met.

(O. Reg. 455/09, s. 13)

The regulation requires that the owner and operator create a record for the tracking and quantification for each prescribed toxic substance at the process level for the calendar year. The process-level quantification may then be used to determine facility-wide quantifications as required for the annual Report.

There is an important provision in the regulation that states that the rules in the NPRI notice with regard to calculating amounts also apply to the calculations for toxic substance accounting. This provision is aimed to leverage the exemption rules

as set out in NPRI that states that a facility does not have to look for the substance in certain activities or "things". For example, the article exemption that applies for NPRI quantifications also applies for Ontario's toxic substance accounting. The owner and operator are encouraged to review the Gazette Notice and NPRI guidance to become familiar with these rules.

There may be many approaches to creating the record for tracking and quantification. A spreadsheet or database may already be used at the facility to keep track of the inventory of substances, materials containing the substance, or due to NPRI, the tracking of emissions, disposals, and transfers of the substances. If it is possible to use these existing tracking methods for the purpose of tracking at the process level, then a facility may reference these systems in the record.

Once a substance has been tracked throughout a process, the prescribed toxic substances must be quantified for the amount that enters the process, is created, transformed, destroyed, transferred for recycling, disposed of, released, and contained in product. Methods for tracking and quantification are described in Section 5.1.

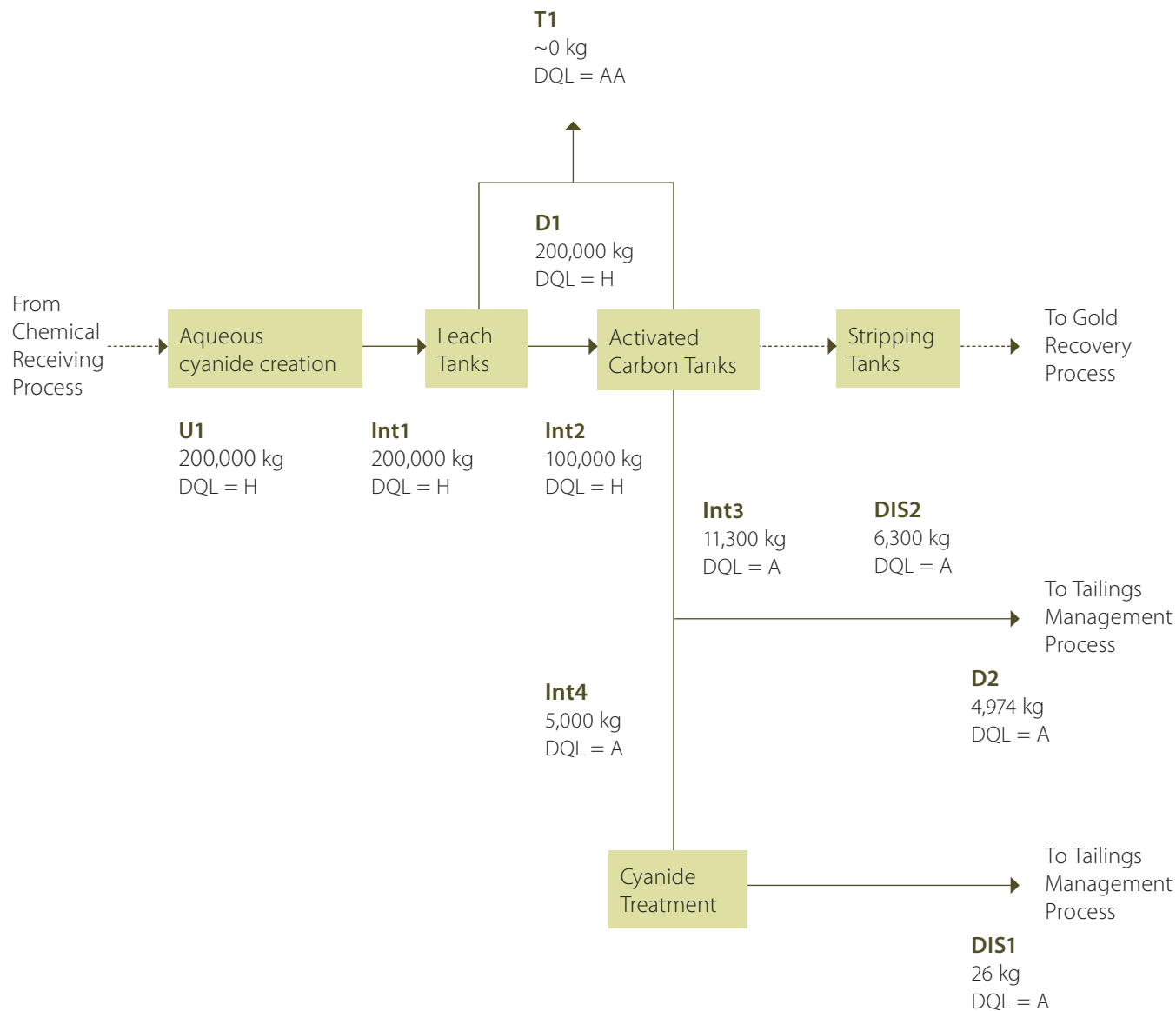
The Regulation states that:

"A process flow diagram mentioned in paragraph 2 of subsection (2) may specify the quantifications made under section 9 of the Act in respect of the toxic substance."

(O. Reg. 455/09, s. 12 (4))

A facility may choose to use a process flow diagram to show actual quantities used, created, transformed, destroyed and released, disposed of, transferred and contained in product, but it is not required.

Figure 11: Cyanides in Ore Extraction Process Flow



Legend

- U** **Toxic** substance enters the process
- T** **Transformation** of toxic substance
- D** **Destruction** of toxic substance
- INT** **Intermediate** step to describe movement of toxic substance within the process
- DIS** **On-site** or **off-site disposal** of toxic substance
- A process where cyanide is present

Figure 11 Description:

Cyanide salt (ionic) is added to water to create an aqueous ionic cyanide in a solution (**U1**). This ionic cyanide solution is added to the raw ore slurry leach tanks. Some of the ionic cyanide bonds with the gold to form aurocyanide in solution. The ionic cyanide that bonds with gold to form aurocyanide is considered to be destroyed. The slurry mixture coming out of the leach tanks (containing water, ground ore, ionic cyanide and aurocyanide (**D1**)) is transferred to activated carbon tanks, where the aurocyanide is adsorbed onto the activated carbon. The slurry in the leach tanks and activated carbon tanks is maintained at a pH of greater than 12 by adding lime to the tanks. This largely avoids the transformation of ionic cyanide to hydrogen cyanide that is released to the air from these activities (**T1**) (although by nature of the chemical reaction, it is less likely to have zero releases of hydrogen cyanide; however, reducing these releases to less than 1% is possible). The gold-loaded carbon from the activated carbon tanks is then transferred to stripping vessels where the gold is removed from the carbon into a solution. The gold solution is then transferred to the recovery process. The spent ore slurry containing the remaining ionic cyanide from the activated carbon tanks (**Int3**) is routed to a cyanide treatment area during the coldest six months of 2010 (**Int4**). In the cyanide treatment area, most of the ionic cyanide is destroyed by being converted into cyanate (**D2**). The treated spent ore slurry, containing the destroyed cyanide along with a small quantity of untreated ionic cyanide, is transferred to the tailings management process (**DIS1**). During the warmest six months of 2010, the spent ore slurry from the activated carbon tanks was transferred directly to the tailings management process, bypassing the cyanide treatment area (**DIS2**).

Refer to the **Example Figure 2-4: Sample Calculations** for supporting information and calculations for Destruction D2.

Refer to the **Example Figure 2-3: Sample Calculations** for supporting information and calculations for Creation C1.

Refer to either **Example Figure 2-3** or **Example Figure 2-4** for an **input/output** balance calculation.

***Note that the quantification values shown in this process flow diagram are **annual** values.*

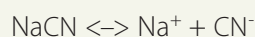
Figure 11 provides an example showing labeled pathways *and* calculated annual quantities in a process flow diagram.

Documenting the calculation is not a regulatory requirement but it may be helpful to give further context to the quantifications provided.

For example for the pathway U1, the supporting calculation is provided below:

Calculation for Amounts of Ionic Cyanide Entering the Process* (U1):

During this process, ionic cyanide enters the process when sodium cyanide (a salt, which is not a prescribed toxic substance) is added to water to create an aqueous solution containing sodium ions and cyanide ions. The chemical equation for this reaction is:



NaCN is sodium cyanide salt, Na^+ is the sodium ion, and CN^- is the cyanide ion. Ionic cyanide is a prescribed toxic substance, and includes the salts of hydrogen cyanide such as sodium cyanide.

It can be reasonably assumed that all of the sodium salt dissolves into ionic form. Since it is known that a total of 377,360 kg of sodium cyanide salt was added to the process in 2010, the quantity of cyanide ion entering the process can be calculated using simple stoichiometry:

Based on the equation above, it is evident that one mole of NaCN yields one mole of Na^+ and one mole of CN^- in aqueous solution. The atomic weights of the individual elements can be found from a periodic table:

Atomic weight of Na = 22.99 grams per mole
(or g/mol)

Atomic weight of C (carbon) = 12.01 g/mol

Atomic weight of N (nitrogen) = 14.01 g/mol

From these atomic weights, one can determine the molar masses of both sodium cyanide and ionic cyanide:

Molar mass of NaCN = 22.99 + 12.01 + 14.01 =
49.01 g/mol

Molar mass of CN^- = 12.01 + 14.01 = 26.02 g/mol

By dividing the molar mass of CN by the molar mass of NaCN, one can then determine the weight percentage of the sodium cyanide salt that consists of ionic cyanide, when in solution.

26.02 g/mol divided by 49.01 g/mol = 0.53, or 53%

If 53% of the weight of the cyanide salt used in 2010 was converted into ionic cyanide, then 377,360 kg of sodium cyanide would yield 377,360 * 53%, or **200,000 kg, of ionic cyanide.**

*based on amounts of cyanide ions

Sample calculations are provided in Section 7.0 for several manufacturing examples. For each route or pathway, the quantification method must be described. For the examples provided in Section 7.0, data quality levels have also been assigned.

If a facility identifies the various pathways by coding them according to type of input and output stream, then it is a simple exercise to add all the similarly coded streams to create the 'roll-up' total facility amount required for reporting.

6.1 Analysis – Input / Output Balances

The input/output balance is a quantitative tool for making a qualitative decision. The intent of an input/output balance exercise is not to obtain a zero balance and it is recognized that this will rarely be achieved. The intent is to use the input/output balance as a qualitative indicator, to

evaluate the approaches chosen for tracking and quantifying the substance and identify where significant data gaps may exist. Reasons for data gaps may be due to a number of factors, such as missing processes or a missing route or pathway on a process flow diagram, or an inaccurate data accounting method, etc. It is acceptable to have a non-zero balance. If a facility determines through input/output balance that the sum of the inputs of the process is not approximately equal to the sum of the outputs, a facility must provide an explanation that describes the cause of the discrepancy. The record outlining the reasons why there is not an approximate balance between inputs and outputs is kept at the facility.

It is acknowledged that toxic substance accounting may be limited by the quality and availability of data. Some instances that may result in unbalanced input/output quantities are:

- Many processes have numerous process streams, many of which affect various environmental media;
- The exact composition of many streams is unknown and cannot be easily analyzed;
- Phase changes occur within the process, requiring multimedia analysis and correlation;
- Plant operations or product mix change frequently, so the material flows cannot be accurately characterized by a single process flow diagram; and
- Many sites lack sufficient historical data to characterize all streams.
- The input/output balance approach allows a facility to confirm that operations that use, create, destroy or transform prescribed toxic substances and those that contribute to appreciable transfers, disposals or releases have not been missed. This helps to ensure that all toxic substance reduction

opportunities can be identified. These balances allow a reviewer or decision maker the opportunity to go back and obtain better data if required.

The input/output balance would be represented as follows, for a prescribed toxic substance (using the annual quantities calculated for these values):

**Enters the Process + Created =
Transformed + Destroyed + Leaves Process**

The term “*Leaves Process*” may include any combination of the following scenarios:

- Contained in product
- Released as air emissions
- Released as liquid or solid waste
- Disposed of
- Transferred off-site for treatment or recycling

The Regulation also states that:

“The record required under paragraph 4 of subsection (2) shall be completed on or before June 1 in the year following the calendar year in which the sums specified in that subsection do not approximately equal each other.”

(O. Reg. 455/09, s. 12 (5))

For some examples the input/output balance is zero. For others, a discrepancy is shown. For each example, the results of the input/output balance is discussed in the context of what the information yields, i.e., is the discrepancy (if one exists) acceptable and if so, why is it acceptable.

7.0 Examples of Toxic Substance Accounting Requirements for Various Manufacturing Industries

7.1	Example 1: Plastic Extrusion Operation	56
7.2	Example 2: Gold Ore Processing Operation	60
7.3	Example 3: Adhesive Manufacturing Operation	66
7.4	Example 4: Wood Furniture Manufacturing Operation	71
7.5	Example 5: Brick Manufacturing	77

Examples of Toxic Substance Accounting Requirements for Various Manufacturing Industries

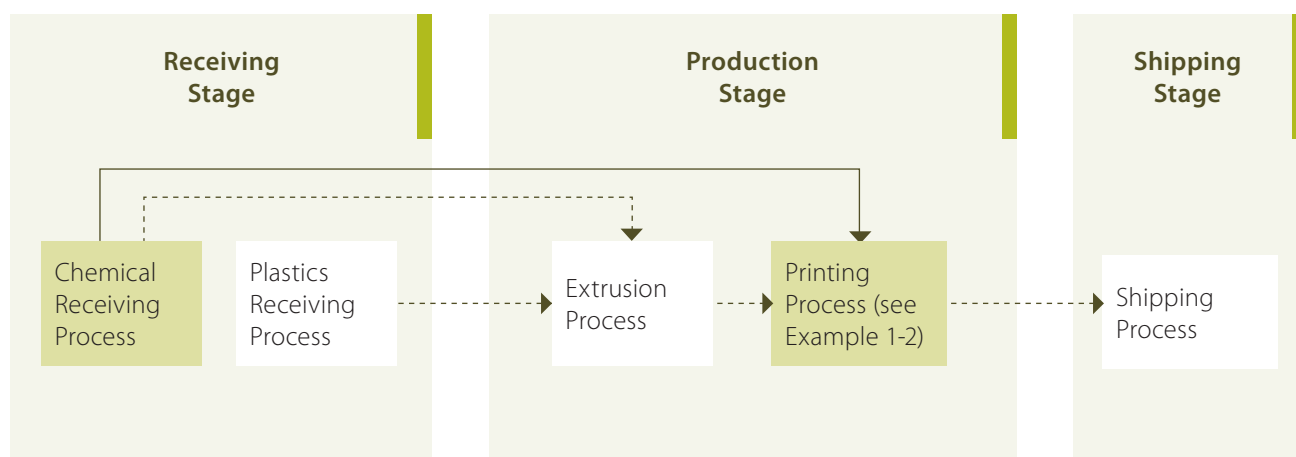
The following subsection (7.1 to 7.5) provides example records for various industrial processes that use and create substances, including descriptions of stages and processes, process flow diagrams, tracking and quantification, description of quantification methods and rationale for the best available method, input/output balance, comments on whether the input/output balance

is approximately equal and where the balance is not approximately equal, a discussion as to why it is not equal and whether the discrepancy is acceptable. The textual description provided in the records are intended to be detailed for guidance purposes but the level of detail is left to the discretion of the facility to determine.

7.1 Example 1: Plastic Extrusion Operation

Examples 1-1 to 1-3 provide examples of all the components of toxic substance accounting for a fictional plastic extrusion operation.

Example 1-1: Illustration Showing Stages and Processes of a Plastics Extrusion Operation (describing Methanol)



Legend

—▶ Production Line (with substance)

- - -▶ Production Line (without substance)

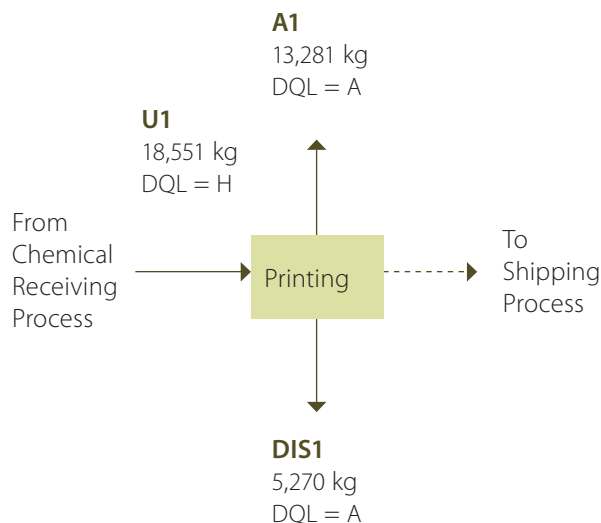
■ A process where methanol is present

Example 1-1 Description:

At the **receiving stage**, plastics and other chemicals are received (at the **plastics receiving process** and the chemical receiving process, respectively). Plastics and other chemicals are transferred to the **extrusion process** of the **production stage**. Extruding machines melt the plastic and other additives (such as colorants) and extrude it into plastic bags of varying sizes and thicknesses, according to customers' specifications.

The plastic bags are then transferred to the **printing process**, which uses solvent-based inks and coatings to print various characters on the plastic bags, again, according to customers' specifications. Methanol is a constituent of the ink used in the printing process. The final product (the plastic bags with printed characters on it) enters the **shipping process** of the **shipping stage**, where it is sent to various customers.


Example 1-2: Detailed Process Flow Diagram – Methanol in Printing Process



Legend

- U** Toxic substance enters the **process**
- A** **On-site release** of toxic substance to air
- DIS** **On-site or off-site disposal** of toxic substance

- DQL** Data Quality Level = **H** "High"
AA "Above-Average"
A "Average"
U "Uncertain"

 A process where methanol is present

Example 1-2 Description:

Methanol is present in the inks and solvents used in the printing process transferred from the chemical receiving process (**U1**). Methanol is the carrier solvent in the ink, and is present at a 25% concentration in the ink purchased from the supplier. Ink is sprayed into extruded parts using an ink-jet printer. After each shift, the printer head and print-head area is cleaned up, by a manual cleaning operation. The cleaning solvent consists of 99% methanol. Operators use rags with pure methanol for this cleaning operation. Methanol is highly volatile, and much of it is released on-site as an air emission from the exhaust vents in the

printing area (**A1**). Waste methanol-ink sludge and methanol-contaminated rags are disposed of in a drum, and periodically shipped off-site for disposal as hazardous waste using a licenced waste hauler (**DIS1**).

****Note that the quantification values shown in this process flow diagram are annual values.**

Example 1-3: Sample For Tracking & Quantification

Amount That Enters The Process: U1

(i.e. methanol entering the printing process from chemical receiving process)

Quantification Method:

Source-specific information (MSDS containing methanol concentrations in, and densities of, ink and cleaning solvent)

Inventory records (quantities of ink and cleaning solvent used in 2010)

Best Available Method Rationale:

Methanol concentrations and product densities

MSDS information showing constituent concentrations and product density is a source of data that is highly reliable. No other alternatives were identified during the evaluation of best available methods that would yield a higher level of data quality/reliability. MSDS records are a common method of obtaining highly reliable data

in a cost effective manner, and in no situations that this facility is aware of would another alternative be recommended to provide a higher level of data reliability.

Ink and cleaning solvent quantities

Quantities of ink and cleaning solvent that are used in the process are recorded by operating and maintenance personnel. These values are cross-checked with purchasing and inventory records. This data is therefore considered to be very reliable. Alternative methods that might yield more reliable data were considered, including an automated process (i.e. continuous monitoring) for tracking the quantities of ink and cleaning solvent that enter the process. With respect to the cleaning solvent, the former alternative is not technically feasible since the cleaning is done by hand. With respect to the ink quantities used, an automated process was determined to be cost prohibitive given the significant equipment changes/updates/additions required, and would yield only a nominal increase in data reliability.

Calculations (intended for guidance purposes only; not required by regulation):

Ink:

<i>Methanol concentration (% w/w):</i>	<i>25 (MSDS – provided 10–30% range)</i>
<i>Total ink used (L):</i>	<i>62695 (Operator usage records for 2010)</i>
<i>Ink Density (kg/L):</i>	<i>0.95 (MSDS)</i>
<i>Total Methanol in Ink (kg):</i>	<i>14890 (methanol concentration * total ink used * ink density)</i>

Cleaning Solvent:

<i>Methanol concentration (% w/w):</i>	<i>99 (MSDS)</i>
<i>Cleaning solvent used (L):</i>	<i>4510 (Maintenance usage records for 2010)</i>
<i>Cleaning solvent density (kg/L):</i>	<i>0.82 (MSDS)</i>
<i>Total methanol in solvent (kg):</i>	<i>3661 (methanol concentration *total solvent used *solvent density)</i> <i>(i.e. 99% * 4510 L * 0.82 kg/L)</i>

Total methanol used in process (kg):

18551 (total methanol in ink + total methanol in solvent)

U1 Total Amount of Methanol that Enters the Printing Process in 2010 (kg) 18,551

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release (to Air, Land, Water) + Off-site Transfers (for Treatment, Recycling)

U1 = A1 + DIS1

18551 kg = 13821 kg + 5270 kg

18551 kg = 18551 kg

Unaccounted material: 0 kg

Comment on Input/Output Balance Results:

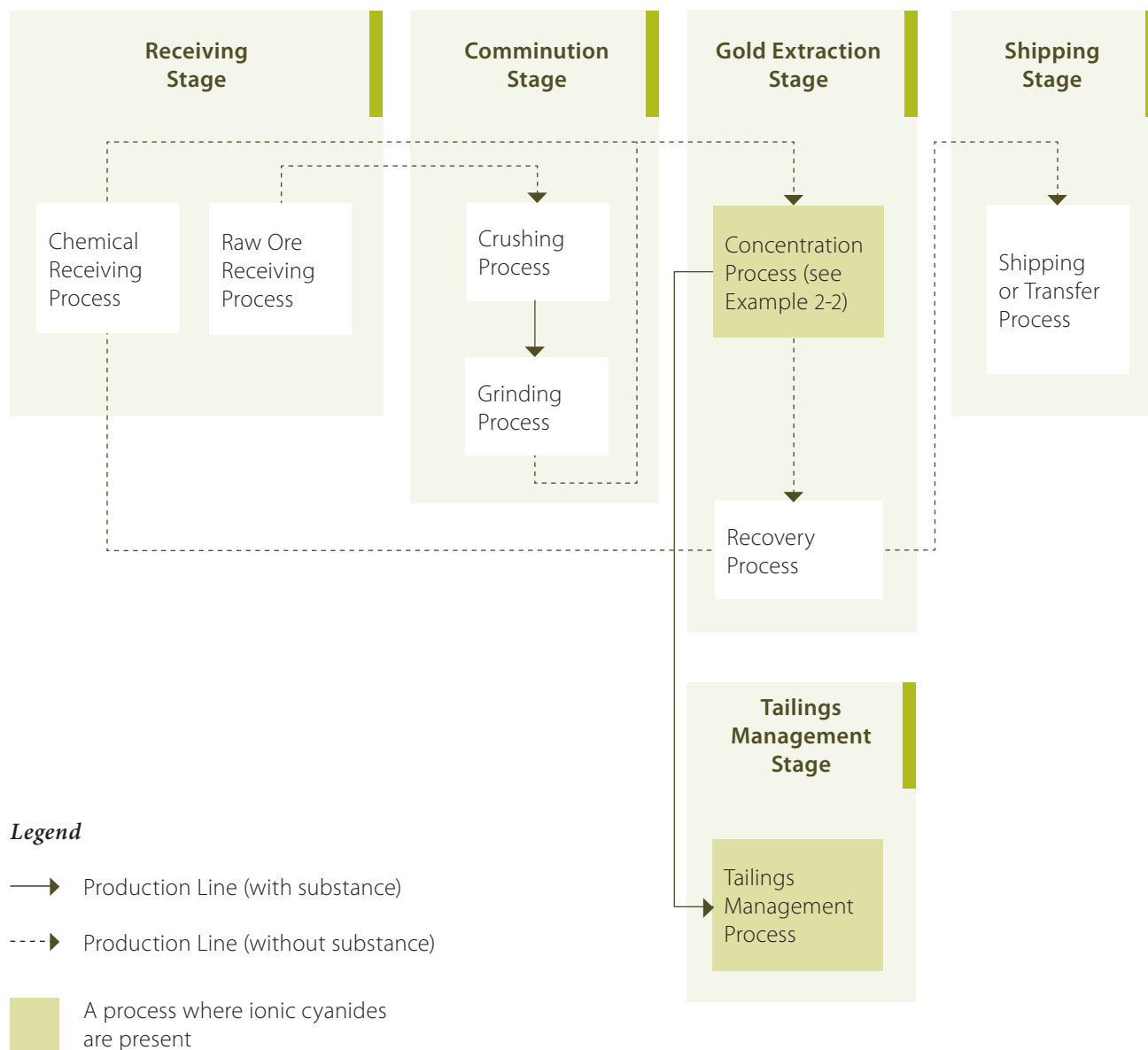
After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. The input/output balance is zero in this case, because the air emissions portion (**A1**) is assumed to be the difference between the amount input from the chemical receiving process (**U1**) and the amount transferred off-site for recycling (**TR1**) (i.e. a mass balance calculation was used in the input/output balance). Because methanol is a volatile compound, it is reasonable to assume that there is no remaining methanol present in the finished product. The amount disposed of off-site is based on the total amount of material shipped off-site shown on waste manifests, and an average concentration of methanol in the waste, as determined by analysis for waste characterization purposes.

Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable. In the coming years, the facility will continue to look for alternate methodologies that provide more reliable data for calculating A1 other than by the current best available method of mass balance, and will evaluate and implement these methodologies in accordance with the Act and Regulation in the future.

7.2 Example 2: Gold Ore Processing Operation

Examples 2-1 to 2-4 provide examples of all the components of toxic substance accounting for a fictional gold ore processing operation.

Example 2-1: Illustration Showing Stages and Processes of a Gold Ore Processing Operation (describing Ionic Cyanides)



Example 2-1 Description:

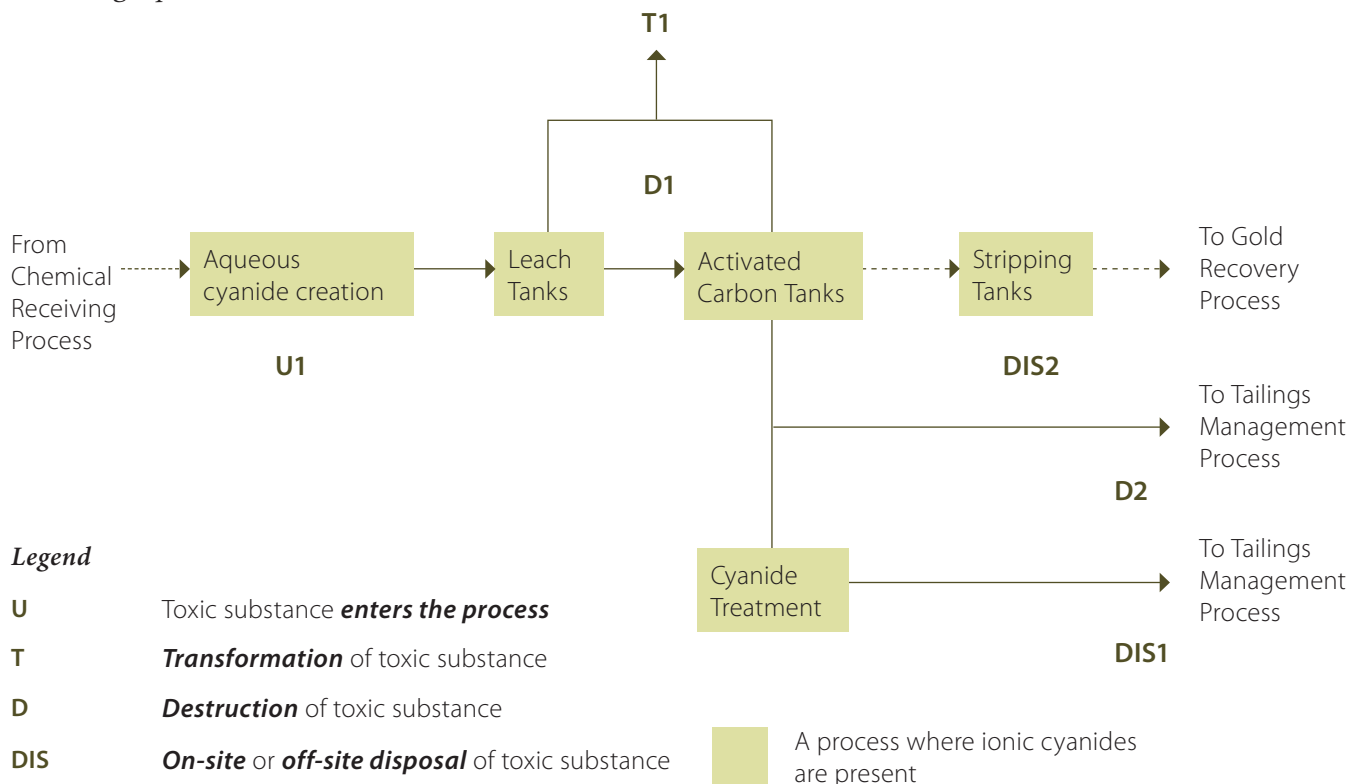
During the **chemical receiving process** of the **receiving stage**, cyanide is received as solid briquettes of sodium cyanide (i.e. a salt in ionic form). The sodium cyanide briquettes are contained in boxes or bins that arrive by rail and truck, and are transferred via forklift to a dry, covered storage area. At the **raw ore receiving process**, raw ore is transferred using open trucks to the receiving area, where it enters the **comminution stage** and undergoes crushing and grinding by mechanical means, during the **crushing process** and **grinding process**, respectively, to reduce the ore's particle size for use in subsequent processes. During the **concentration process** of the **gold extraction stage**, the cyanide salt is first added to water to create an aqueous solution containing cyanide IONS. The ground ore is also liquified by adding water to create a slurry, in a series of tanks referred to as leach tanks. The ionic cyanide solution is added to the leach tanks containing the slurry. Ionic cyanide binds with the gold to create a dissolved metal-cyanide complex within the slurry. This dissolved gold-cyanide complex is adsorbed out of the slurry by the subsequent activated carbon tanks through which the slurry is passed. At this point, the waste slurry is separated from the gold-loaded carbon using screens and is transferred to cyanide treatment, where the bulk of the ionic cyanide in the waste slurry is converted into cyanate via an oxidation process. The gold-loaded carbon is transferred to a vessel where the gold is stripped from the carbon using a chemical solution. The chemical solution from the stripping activity is transferred to the **recovery process**, where the gold is precipitated out of the solution by passing the solution through electrowinning cells. The precipitated gold is then washed with solution to remove it from the electrowinning cells and the

gold-containing solution is dried (or dewatered) to remove the excess solution. The dewatered gold is heated in a furnace to melt it, and is poured into moulds. Once cooled and solidified, the gold is removed from the moulds and enters the **shipping stage**, where it is stored, and shipped off-site.

The cyanide-treated waste slurry from the **concentration process** are transferred to the **tailings management process**, where the tailings are collected in a tailings pond for further treatment. The small concentrations of ionic cyanide that may remain in the tailings emerging from the cyanide treatment activity are further reduced in the tailings pond via natural attenuation reactions.

In 2010, the gold ore processing operation ran essentially all year round, 24 hours per day, 7 days per week. The cyanide treatment activity in the **concentration process** ran for six months (the coolest months of the year). During the remaining six warmer months, the waste slurry collected from the activated carbon tanks was transferred directly to the **tailings management process**, since the warm, sunny conditions allowed for adequate destruction of the ionic cyanide from natural attenuation, without the need to use the cyanide treatment beforehand.

Example 2-2: Process Flow Diagram – Ionic Cyanides in Concentration Process of Gold Ore Processing Operation



Example 2-2 Description:

Sodium Cyanide (as an ionic cyanide) is added to water to create an aqueous ionic cyanide solution (U1). This ionic cyanide solution is added to the raw ore slurry leach tanks. Some of the ionic cyanide bonds with the gold to form aurocyanide in solution. The ionic cyanide that bonds with gold to form aurocyanide is considered to be destroyed. The slurry mixture coming out of the leach tanks (containing water, ground ore, ionic cyanide and aurocyanide (D1)) is transferred to activated carbon tanks, where the aurocyanide is adsorbed onto the activated carbon. The slurry in the leach tanks and activated carbon tanks is maintained at a pH of greater than 12 by adding lime to the tanks. This largely avoids the transformation of ionic cyanide to hydrogen cyanide that is released to the air from these activities (T1) (although by nature of the chemical reaction, it is less likely to have zero

releases of hydrogen cyanide; however, reducing these releases to less than 1% is possible). The gold-loaded carbon from the activated carbon tanks is then transferred to stripping vessels where the gold is removed from the carbon into a solution. The gold solution is then transferred to the recovery process. The spent ore slurry containing the remaining ionic cyanide from the activated carbon tanks is routed to a cyanide treatment area during the coldest six months of 2010. In the cyanide treatment area, most of the ionic cyanide is destroyed by being converted into cyanate (D2). The treated spent ore slurry, containing the destroyed cyanide along with a small quantity of untreated ionic cyanide, is transferred to the tailings management process (DIS1). During the warmest six months of 2010, the spent ore slurry from the activated carbon tanks was transferred directly to the tailings management process, bypassing the cyanide treatment area (DIS2).

Example 2-3: Sample for Tracking & Quantification

Amount That Enters The Process: U1
(i.e. creation of ionic cyanide from introduction of sodium cyanide into solution)

Quantification Method:

Direct measurement of sodium cyanide added to process

Assume that, once in solution, all cyanide is present as ionic cyanide (reasonable assumption since pH above 11 is maintained throughout process)

Best Available Method Rationale: Sodium Cyanide quantity

The quantity of sodium cyanide that is introduced into solution is tracked and recorded by facility personnel. These values are cross-checked with inventory records for quality control on a weekly basis. This site-specific method is therefore considered to be of very high quality. Alternative methods that might yield more reliable data were considered, including: 1) an automated process

for tracking these quantities, and 2) more frequent cross-checking. The former alternative was not chosen because of economic and technical achievability limitations (i.e. designing and implementing site-specific continuous monitoring equipment for our facility's particular operational equipment configuration), particularly considering the high level of data quality already being achieved. The latter alternative has already been evaluated and implemented in previous years, and the current frequency has proven to be very effective in identifying and correcting any discrepancies.

Quantification of ionic cyanide

Given the assumption stated above in the "Quantification Method" section, the quantification of cyanide ion from the sodium cyanide quantity involves a simple molar mass ratio calculation. Since this estimation method is based upon stoichiometric principles, it is considered to yield the highest quality and reliability of data possible (again, based on the assumption above).

Calculations (intended for guidance purposes only; not required by regulation):

<i>Sodium cyanide entered the process in 2010 (kg):</i>	<i>377,360 (usage records for 2010)</i>
<i>Atomic weight of sodium or Na (g/mol):</i>	<i>22.99 (periodic table)</i>
<i>Atomic weight of carbon or C (g/mol):</i>	<i>12.01 (periodic table)</i>
<i>Atomic weight of nitrogen or N (g/mol):</i>	<i>14.01 (periodic table)</i>
<i>Molecular weight of sodium cyanide or NaCN (g/mol):</i>	<i>49.01 (sum of atomic weights of Na, C and N)</i>
<i>Molecular weight of ionic cyanide or CN⁻ (g/mol):</i>	<i>26.02 (sum of atomic weights of C and N)</i>
<i>Percent of sodium cyanide consisting of ionic cyanide (%):</i>	<i>53 (molecular weight of CN⁻ divided by molecular weight of NaCN * 100)</i>
<i>Ionic cyanide entered the process in 2010 (kg):</i>	<i>200,000 (sodium cyanide usage * percentage cyanide ion) (i.e. 377,000 kg * 53%)</i>

U1 Ionic cyanide quantity that entered the process in 2010 (kg): 200,000

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release (to Air, Land, Water) + Off-site Transfers (for Treatment, Recycling)

$$U1 = D1 + D2 + T1 + DIS1 + DIS2$$

$$200,000 \text{ kg} = 190,000 \text{ kg} + 4,974 \text{ kg} + 0 \text{ kg} + 26 \text{ kg} + 6,300 \text{ kg}$$

$$200,000 \text{ kg} = 201,300 \text{ kg}$$

Unaccounted material: 1,300 kg

Comment on Input/Output Balance Results (intended for guidance purposes only):

After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. It is likely that the difference in the input/output balance is related to the uncertainties in the calculations for destruction and output to the tailings pond. The values for D2, DIS1 and DIS2 are based upon a limited number of sample results, which result in limited accuracy due to the heterogeneous nature of the raw ore. Another contributing factor would be the upstream variability in the addition of various chemicals and the changes in various operating conditions to account for the differing raw ore gold concentration estimates from a limited number of test assays. Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable.

Example 2-4: Sample For Tracking & Quantification

Destruction: D2 (i.e. conversion of cyanide to cyanate during cyanide treatment)

Quantification Method:

Free cyanide concentrations from source sampling of influent and effluent of cyanide treatment activity using silver nitrate titration

Direct measurement of influent volume from flow metre and automated data collection system.

Assume that free cyanide consists completely of ionic cyanide (reasonable assumption since pH above 11 is maintained throughout process)

Assume that influent volume is equal to effluent volume (reasonable assumption since volume of spent ore slurry in cyanide treatment area is constant)

Best Available Method Rationale:

Influent and effluent ionic cyanide concentrations

Source samples of influent and effluent are collected using a 24-hour composite sampler once per week and analyzed. This site-specific source of data provides a high level of reliability. The only other alternatives identified during the analysis of the best available method that might yield more reliable data were to either 1) implement continuous monitoring of the influent and effluent ionic cyanide concentrations; and 2) to increase source testing frequency. The former alternative was not chosen because of economic and technical achievability limitations (i.e. designing and implementing site-specific continuous monitoring equipment for our facility's particular operational equipment configuration). The latter alternative

(i.e. more frequent sampling) has been assessed in terms of the balance between data reliability and cost, yielding the current sampling frequency. The current sampling frequency also surpasses those recommended by relevant industry standards.

Influent volume

As stated in the Quantification Method section, influent flow rates are measured continuously by an in-situ flow metre and are collected by an automated system. This data system uses the flow rate measurements and calculates the total volume of influent over time. This data system can be queried to provide total volumes over any requested time period. Continuous monitoring is considered to be a highly reliable source of data. This data source is considered to be the best available method, as no other alternatives could provide more reliable data.

Quantification of ionic cyanide

Although it was initially internally proposed to use the average annual concentrations of the influent

and effluent source sampling results and multiply it by the volumes of influent and effluent over the 2010 year, respectively, another alternative was identified that would yield more reliable data. The current quantification method used is to multiply the weekly sampling results by the volume of influent/effluent for one week starting at the date and time of sample collection. This quantifies ionic cyanide on a weekly basis. These weekly quantities could then be added to determine the total quantity for the 2010 year. The initial suggested method of using the annual average concentration would have yielded data with high reliability; however, the current method employed does not differ significantly in cost, and yields data with an even higher level of reliability. During the analysis of the best available method for this calculation, increased influent and effluent sampling frequency was considered; please refer to the discussion and decisions made around this alternative in the above text shown under “Influent and effluent ionic cyanide concentrations” in this Best Available Method Rationale section.

Calculations (intended for guidance purposes only; not required by regulation):

Ionic cyanide in influent to cyanide treatment in 2010 (kg): 5000 (sum of weekly sample results of influent free cyanide concentrations multiplied by the weekly volume of influent obtained from data queries, over the 2010 year)

Ionic cyanide in effluent from cyanide treatment in 2010 (kg): 26 (sum of weekly sample results of effluent free cyanide concentrations multiplied by the weekly volume of influent obtained from data queries, over the 2010 year)

D2 Ionic cyanide destroyed during cyanide treatment (kg): 4,974 (ionic cyanide in influent minus ionic cyanide in effluent)

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release (to Air, Land, Water) + Off-site Transfers (for Treatment, Recycling)

$$U1 = D1 + D2 + T1 + DIS1 + DIS2$$

$$200,000 \text{ kg} = 190,000 \text{ kg} + 4,974 \text{ kg} + 0 \text{ kg} + 26 \text{ kg} + 6,300 \text{ kg}$$

$$200,000 \text{ kg} = 201,300 \text{ kg}$$

Unaccounted material: 1,300 kg

Comment on Input/Output Balance Results:

After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. It is likely that the difference in the input/output balance is related to the uncertainties in the calculations for destruction and output to the tailings pond. The values for D2, DIS1 and DIS2 are based upon a limited number of sample results, which result in limited accuracy due to the heterogeneous nature of the raw ore. Another contributing factor would be the upstream variability in the addition of various chemicals and the changes in various operating conditions to account for the differing raw ore gold concentration estimates from a limited number of test assays. Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable.

7.3 Example 3: Adhesive Manufacturing Operation

Examples 3-1 to 3-3 provide examples of all the components of toxic substance accounting for a fictional adhesive manufacturing operation.

Example 3-1: Illustration Showing Stages and Processes of an Adhesive Manufacturing Operation (describing Zinc)

Receiving Stage
Receiving Process

Production Stage
Reactor Process

Shipping Stage
Shipping Process

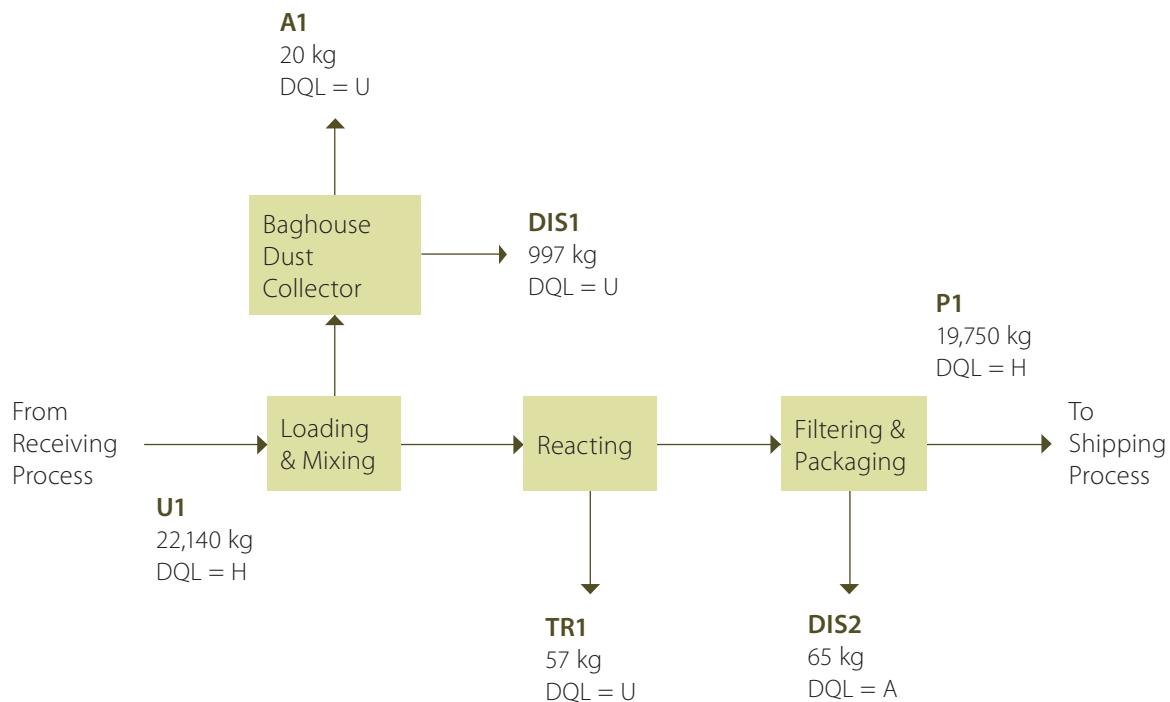
Example 3-1 Description:

The adhesive manufacturing operation receives raw materials at the receiving process of the receiving stage. At the production stage, the reactor process consists of several batch reactors (i.e. vessels that operate in batch mode). These batch reactors are filled with raw materials and mixed, heated and cooled to produce (by chemical reaction) the desired product, which is then filtered and poured

into containers. In the shipping stage, the final product is sent to customers during the shipping process.

During 2010, the adhesive manufacturing operation ran for two shifts per day, five days per week, throughout the year (with the exception of two weeks where operations were suspended for scheduled maintenance).

Example 3-2: Process Flow Diagram – Zinc in Reactor Process



Legend

- U** **Use** of toxic substance
- P** Toxic substance **contained in product**
- A** **On-site release** of toxic substance to **AIR**
- TR** **Off-site transfer**
- DIS** **On-site** or **off-site disposal** of toxic substance
- DQL** Data Quality Level = **H** "High"
 AA "Above-Average"
 A "Average"
 U "Uncertain"



A process where zinc is present

Example 3-2 Description:

Zinc is present as an ingredient used in the manufacturing of water-based adhesives, because it provides a desired adhesion characteristic. Powder raw materials (one containing zinc) are manually loaded into the reactor from the receiving process (**U1**) and undergo mixing with other ingredients. The mixing activity creates some dust, which is extracted to a baghouse dust collector. Some of the dust contains zinc. Most of the dust is captured by the baghouse dust collector, but a small portion is released as an air emission to the atmosphere (**A1**). Dust that has been captured by the baghouse dust collector is disposed of off-site (**DIS1**).

During the reacting activity, the lid is closed on the reactor, and the reactor is heated to a desired temperature and pressure, in order to “cook” the batch to produce the desired product. Subsequently, the reactor is cooled. Both the heating and cooling treatments are by non-contact heat transfer, using closed-loop coils in the reactor. Thus, there are no material losses during the reacting activity. In addition, zinc, being a metal, is not created or destroyed in the reactor process.

Once the “batch” of product has been made, it is subsequently pumped out of the reactor through filters and packaged for shipping. This step creates used filters, as a waste stream, that are known to contain minor amounts of zinc (**DIS2**). The amount of zinc in the product (**P1**) transferred to the shipping process is monitored for quality control purposes, and is known with a high degree of certainty. The amount of zinc in the used filters is based on analysis of a sample.

After the reactor is drained of product, it is washed before use for the next “batch”. During reactor washing, operators use high pressure water to remove residual product from the reactor

vessel, and this creates a wastewater stream. This wastewater contains trace amounts of zinc, and the wastewater is discharged to the sanitary sewer connection at the facility (**TR1**).

** Note that the quantification values shown in this process flow diagram are annual values.

Guidance Notes For Example 3-2:

This toolkit refers only to “Contained in Product P1” in the “Example 3-3: Sample Calculations” in the “Example 3-2 Description” box.

Example 3-3: Sample For Tracking & Quantification

Contained in Product: P1 (i.e. zinc contained in product transferred to shipping process)

Quantification Method(s):

In-house analytical test results of zinc concentration in product (i.e. sampling), using atomic absorption spectroscopy

Records showing quantity of product transferred to shipping process

Best Available Method Rationale: Zinc concentration

Zinc concentration is determined by in-house laboratory quality control analysis. Representative batches of product are analyzed daily for zinc content, since this measurement is a statistical process control parameter. In other words, there is a target concentration range of zinc in the product that must be achieved, and this range is very small (i.e. 3.9% to 4.1%). Any product batches whose zinc concentration results fall outside that range are re-worked, and therefore are NOT transferred to the shipping process. As such, this method has a high level of data quality. The only other methods that could yield better quality data would either be continuous monitoring, or a higher frequency of the current sampling and

testing regime. The former method (continuous monitoring) is not technically logical, since every single product cannot be tested in its entirety. The latter alternative (i.e. more frequent on-site product testing) has been assessed in terms of the balance between: 1) data quality, and 2) cost associated with analytical testing and product yield. The current frequency has been determined to be the best balance between data quality and cost. The current testing frequency also surpasses the testing frequency recommended by relevant industry standards.

Product quantity

The product quantity that is transferred to the shipping process is tracked and recorded by facility personnel. These values are cross-checked with inventory records for quality control weekly. This site-specific method is therefore considered to be of very high quality. Alternative methods that might yield more reliable data were considered, including: 1) an automated process for tracking these quantities, and 2) more frequent cross-checking. The former alternative is cost-prohibitive, particularly considering the high level of data quality already being achieved. The latter alternative has already been implemented in previous years, and the current frequency has proven to be very effective in identifying and correcting any discrepancies.

Calculations (intended for guidance purposes only; not required by regulation):

Zinc concentration in product (%):

4.0 (average concentration from sampling results in 2010)

Total product shipped (kg)

493,750 (total 2010 quantity taken from transfer records)

Total zinc in product (kg):

*19,750 (zinc concentration * product shipped)
(i.e. 4.0% * 493750 kg)*

P1 Zinc contained in product transferred to shipping process in 2010 (kg): 19,750

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release (to Air, Land, Water) + Off-site Transfers (for Treatment, Recycling)

$$UI = A1 + TR1 + DIS1 + DIS2 + P1$$

$$22140 \text{ kg} = 20 \text{ kg} + 57 \text{ kg} + 997 \text{ kg} + 65 \text{ kg} + 19750 \text{ kg}$$

Unaccounted material: 1,251 kg

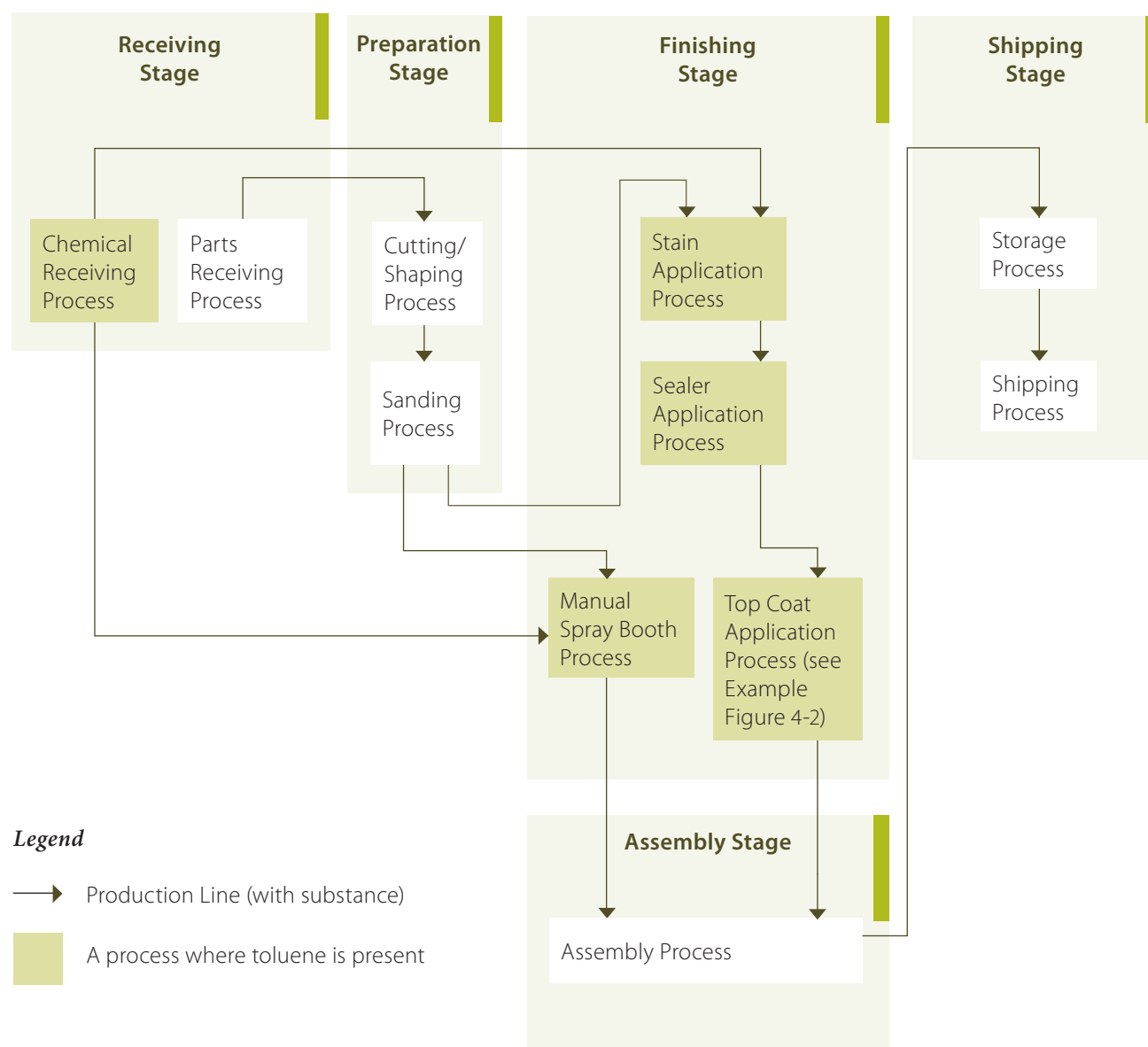
Comment on Input/Output Balance Results (intended for guidance purposes):

After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. It is likely that the difference in the input/output balance results from the a combination of the accuracy of the wastewater value (TR1), the air emission value (A1), the waste dust value (DIS1) and the waste filter value (DIS2). The air emission value is based on a baghouse dust collector particulate emission factor of 20 mg/m³, and then an average zinc concentration. The dust collector emission factor, while commonly used as a conservative estimate of baghouse performance, is not site specific and therefore has some margin of error. In addition, the zinc content in the waste (DIS1) and the waste filter (DIS2) are based on a single annual sample for waste characterization. Also, the wastewater discharge concentration is based on daily zinc concentration sampling results, while there may be some variation throughout the day. Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable.

7.4 Example 4: Wood Furniture Manufacturing Operation

Examples 4-1 to 4-3 provide examples of all the components of toxic substance accounting for a fictional wood furniture manufacturing operation.

Example 4-1: Illustration Showing Stages and Processes of a Wood Furniture (Kitchen Cabinet) Manufacturing Operation (describing Toluene)



Example 4-1 Description:

During the receiving stage, wood parts are received during the parts receiving process by truck. Stains, coatings, sealers and solvents (some of which contain toluene) are received during the chemical receiving process via truck in drums and pails, and are transferred to a dedicated chemical storage area via forklifts. During the preparation stage, wood parts are cut and shaped to the desired specifications using an automated cutting and shaping process. During the sanding process, the wood parts are then sanded to smooth rough edges and surfaces, either via an automated process, or by hand, depending upon the shape and/or configuration of the part. The sanded parts are transferred to the stain application process in the finishing stage. The chemicals containing toluene are transferred from the chemical receiving process to be used in the stain application process in the finishing stage. The stains, top coats and sealers are applied to the parts using an automated spraying process, whereby the parts are put on conveyors which move the parts through both the enclosed spray chambers, and the curing ovens, within the finishing process. The enclosed spraying chambers are equipped with automated sprayers that are controlled to specify various spraying parameters to minimize overspray. Overspray is collected in trenches in the floors of the chambers and stored for off-site haulage for either disposal or recycling, depending upon the contents, which are periodically tested by the receivers. After each application of stain, top coat or sealer, the parts are dried in curing ovens. Finally, the parts are assembled during the assembly process into the final products, at which time they are stored and ultimately shipped.

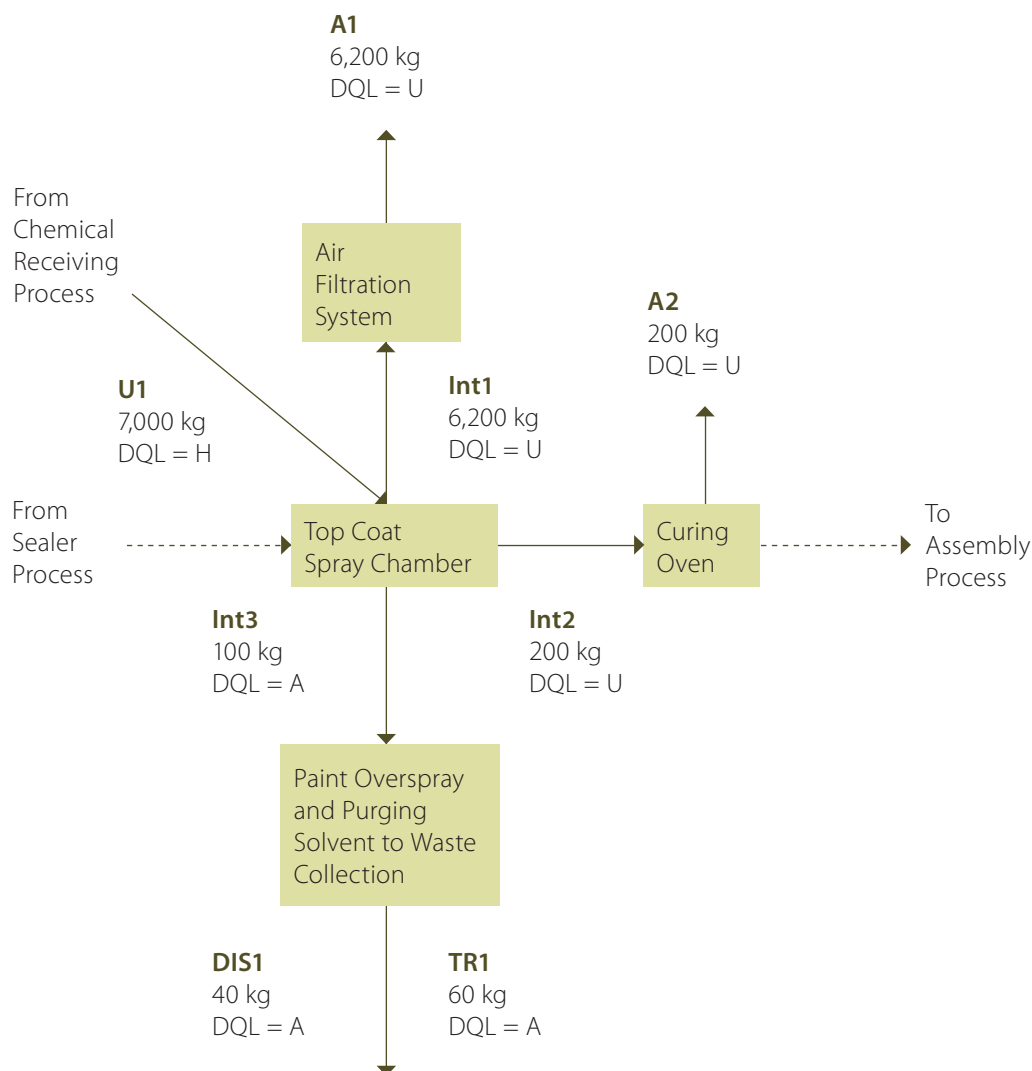
The spray guns are purged using a solvent in between manufacturing specification changes.

The purge solvent is collected and stored separately, some of which is recycled on-site, or hauled off-site for recycling, depending upon the quality of the purge solvent.


The facility operated an average of 16 hours per day, 6 days per week during 2010.

The facility also operates a manual spray booth process within the finishing stage, for parts that have more complex figurations, or that are manufactured in small quantities. The manual spray booth has an exhaust system equipped with filtration for overspray. There is no collection of liquid from the manual spray booth – very little liquid accumulates within the spray booth, and that which does is simply left to evaporate. The painted parts are manually transferred to a ventilated storage area to dry. The manual spray booth was operated for a total of approximately 800 hours during 2010.

Example 4-2: Process Flow Diagram – Toluene in Top Coat Application Process



Legend

U	Use of toxic substance	DIS	On-site or Off-site Disposal of toxic substance
Int	Intermediate step to describe movement of toxic substance within the process	DQL	Data Quality Level = H "High" AA "Above-Average" A "Average" U "Uncertain"
A	On-site release of toxic substance to AIR		
TR	Off-site Transfer of toxic substance for treatment or recycling		
			A process where toluene in top coat application is present

Example Figure 4-2 Description:

Toluene is present in some of the top coats that are transferred from the chemical receiving process, and are applied to the wood components in the top coat spray chamber (**U1**). Toluene emissions from the top coat spray chamber are vented (moved) to the spray chamber's air filtration system (**Int1**) and pass through untreated as an on-site release to air (**A1**). Any toluene still present in the top coat on the part is transferred to the curing oven (**Int2**), and is subsequently released to the atmosphere from the curing ovens (**A2**).

Overspray is collected from the top coat spray booth using a trench that transfers the waste liquids via gravity to a receiving container (**Int3**). The stored waste liquids are then tested by potential receivers to determine whether the liquids are fit for recycling or for disposal. During 2010, some of the paint overspray collected from the top coat spray chamber was transferred off-site for recycling (**TR1**), and the remainder was disposed of off-site (**DIS1**).

** Note that the quantification values shown in this process flow diagram are annual values.

Guidance Notes For Example 4-2:

This guidance document refers only to "Off-Site Transfer TR1" in "Example 4-3: Sample For Tracking & Quantification Calculations". This is because this example is limited to only this particular calculation. In accordance with the Regulation, however, all of the values provided in this process flow diagram would require similar information to that provided for TR1 in "Example 4-3: Sample For Tracking & Quantification Calculations".

Example 4-3: Sample For Tracking & Quantification

Off-Site Transfer for Recycling: TR1

Quantification Method(s):

Site-specific source testing of solvent waste taken and analyzed by hauler using gas chromatography.

Manifest records showing volumes of waste solvent transferred off-site.

Best Available Method Rationale:

Toluene concentration

Prior to transfer, the hauler collects a sample of waste solvent from the container. This sample is tested by the potential receiver/recycler to determine whether the waste solvent is suitable for recycling or for disposal. The facility receives the results of the analysis which include the concentration of toluene. Certain factors, including 1) the collection and analysis of only one sample from each particular shipment of waste solvent, and 2) the lack of control over the manner of sample collection and transfer, yield data quality that has only fair reliability (particularly when used to estimate the total quantity of toluene in the

shipment. During the identification and evaluation of other quantification methods, it was concluded that any type of data collection improvement such as continuous monitoring or facility-initiated sampling frequencies were not economically practical, given that this is a waste stream that in some cases incurs cost for transfer.

The current calculation approach, however, is determined to be the best available method when considering other options such as a mass balance approach. For quality purposes, the facility does request a copy of the analytical report and review the report's quality information and chain of custody information.

Waste Solvent Quantities

The volume of each individual waste solvent shipment is recorded by the hauler at the time of collection. This quantity is cross-checked by the facility's waste inventory records. This method is therefore considered to be of very good quality. No alternative methods were identified during the best available method evaluation that could provide a more reliable value.

Calculations (intended for guidance purposes only; not required by regulation):

<i>Density of toluene at 20 deg Celsius (kg/L):</i>	<i>0.86 (chemical property) in 2010)</i>
<i>Range of individual shipment volumes of solvent waste (L):</i>	<i>100 to 350 (individual quantities taken from shipment records)</i>
<i>Range of individual shipment toluene concentrations (%):</i>	<i>20 to 60 (records received from potential receiver/recycler)</i>
<i>Total quantity of toluene transferred for recycling (kg):</i>	<i>60 (sum of each individual toluene concentration result multiplied</i>

TR1 Total toluene off-site transfer for recycling from top coat booth in 2010 (kg): 60

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release (to Air, Land, Water) + Off-site Transfers (for Treatment, Recycling)

$$U1 = A1 + A2 + DIS1 + TR1$$

$$7,000 \text{ kg} = 6,200 \text{ kg} + 200 \text{ kg} + 40 \text{ kg} + 60 \text{ kg}$$

$$7,000 \text{ kg} = 6,500 \text{ kg}$$

Unaccounted for material: 500 kg

Comment on Input/Output Balance Results (intended for guidance purposes only):

After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. It is likely that the difference in the input/output balance results from a combination of factors, including the following: The air emissions from the spray chamber and the curing oven are based on stack testing that was done in 2010 (providing only two samples) in accordance with the Certificate of Approval (Air) requirement. It should also be noted that the stack tests were performed during maximum emission scenario conditions, which would not reflect conditions throughout the entire year. In addition, the quantities related to off-site disposal and off-site recycling were calculated using test results from the receivers; however, these test results reflect the toluene quantity for liquid from all of the spray chambers, since the overspray from all sources are collected and stored in a single container.

Given these conditions, the calculations were based on estimates of relative quantities of overspray produced from each spray chamber, which is less accurate than if the overspray from the top coat spray chamber was tested on its own. Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable. In the coming years, the facility will continue to look for alternate methodologies that provide more reliable data for calculating A1 other than by the current best available method of mass balance, and will evaluate and implement these methodologies in accordance with the Act and Regulation in the future.

7.5 Example 5: Brick Manufacturing

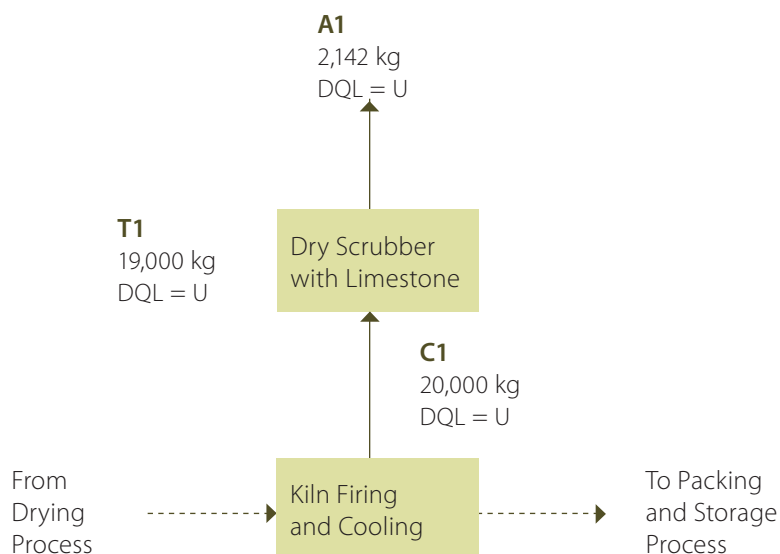
Examples 5-1 to 5-3 provide examples of all the components of toxic substance accounting for a fictional brick manufacturing facility.

Example 5-1: *Description of Stages and Processes of a Brick Manufacturing Operation (describing Hydrogen Fluoride*)*

Hydrogen fluoride is a by-product of fluorine. Fluorine is introduced as a constituent in the natural raw materials (including clays and shales). Assay tests showed a range of fluorine concentrations from 0.02 to 0.05 percent by weight for the raw material received in 2010. During the raw material receiving process of the receiving stage, the raw materials are received in bulk by covered dump trucks from an on-site quarry, and are dumped into a hopper which transfers the raw material via an underground conveyor system to a storage area. Chemicals such as pigments are received during the chemical receiving process via truck and are transported to a storage area via forklift. During the preparation stage, the raw material passes through the crushing, grinding and screening processes by mechanical means. During the production stage, the ground, screened clay and shale is mixed with water to a desired consistency, and pigments are added to customers' specifications. In the forming and cutting process, the mixture is extruded and cut by mechanical means, into bricks sized according to customers' specifications. The bricks from the forming and cutting process enter the drying process to remove excess moisture from the bricks. The dryers typically are heated to approximately 200 degrees Celsius using waste heat from the cooling zone of the kiln. The dried bricks are collected from the drying process and loaded into the kiln firing and cooling process, where the bricks are fired to temperatures reaching between 500 and 600 degrees Celsius. During both the drying process and the kiln firing and cooling process (see example 5-2), some of the fluorine present in the bricks is transformed to hydrogen fluoride gas by dehydroxylation. Hydrogen fluoride gas is collected and treated using a dry scrubber containing limestone. The cooled bricks are transferred to the shipping stage, where they are packed, stored and eventually shipped.

The brick manufacturing facility generally operates year-round, 24 hours per day, 7 days per week, with the exception of scheduled maintenance. Most of the processes run continuously, with the exception of the drying process and kiln firing and cooling process, which are batch processes that shut down between filling and emptying, since the dryers and kilns must be full before they are run.


Example 5-2: Process Flow Diagram – Hydrogen Fluoride in Kiln Firing and Cooling Process



Legend

C **Creation** of toxic substance
T **Transformation** of toxic substance
A **On-site release** of toxic substance to **AIR**

DQL Data Quality Level = **H** "High"
AA "Above-Average"
A "Average"
U "Uncertain"

 A process where hydrogen fluoride is present

Example 5-2 Description:

Hydrogen fluoride emissions are created (**C1**) during kiln firing when some of the fluorine present in the raw material is transformed to hydrogen fluoride. The emissions are collected in a dry scrubber that uses limestone as a sorption medium to eliminate some of the hydrogen fluoride emissions, which form a thin layer of calcium fluoride, a Phase II substance (**T1**), over the limestone granules. This layer is periodically removed from the scrubber and screened. Any hydrogen fluoride which is not captured by the limestone scrubber is released as on-site air emissions (**A1**).

***Note that the quantification values shown in this process flow diagram are annual values.*

Hydrogen fluoride is not included in table A of Reg 455/09 , and therefore is not required to start being tracked and quantified until the year 2012

Example 5-3: Sample For Tracking & Quantification

On-Site Release to Air: A1 (i.e. untreated hydrogen fluoride emitted to air after limestone scrubber)

Quantification Method(s):

Site-specific source testing of hydrogen fluoride from limestone scrubber

Operator records indicating kiln operating hours

Best Available Method Rationale: Hydrogen fluoride emission rate

Site-specific source tests of the limestone scrubber stack were completed in accordance with the requirements of the facility's Certificate of Approval (Air). Three air samples were collected and analyzed in 2010. The average of these sample results was used in the calculation of the total hydrogen fluoride emissions to air in 2010. Although site specific source testing generally yields more reliable data than many other estimation methods, it should be noted that these samples are collected during the facility's "maximum emission scenario", which is when the kiln is operating at its highest temperature. This yields an overall emission value that therefore may be higher than the actual emission rate. However, the heterogenous nature of the raw material constituents (in this case, fluorine) is such that, overall, three samples taken

over the course of one year yields data that, while of reasonable quality, cannot be considered to have extremely high quality.

When compared to other data sources during the analysis of the best available method, however, this method is still considered to be one of the best approaches. Other alternatives that could yield higher quality data include: 1) implementation of continuous monitoring; and 2) an increase in source testing frequency. Neither of these alternatives were chosen due to the associated high costs.

Kiln operating hours

Kiln start and finish times are recorded by facility personnel. These values are cross-checked on a weekly basis with kiln temperatures that are automatically recorded on wheel charts. This site-specific method is therefore considered to be of very high quality. Alternative methods that might yield more reliable data were considered, including: 1) an automated process that logs start and finish times and 2) more frequent cross-checking. The former alternative is cost-prohibitive, particularly considering the high level of data quality already being achieved. The latter alternative has already been evaluated and implemented in previous years, and the current frequency has proven to be very effective in identifying and correcting any discrepancies.

Calculations (intended for guidance purposes only; not required by regulation):

<i>Hydrogen fluoride emissions from scrubber (g/s):</i>	<i>0.082 (average of three stack test results)</i>
<i>Kiln operation in 2010 (hours):</i>	<i>7255 (sum of the recorded kiln operating times for 2010)</i>
<i>(example calculation: $0.082 \text{ g/s} \times 3600 \text{ s/hr} \times 1/1000 \text{ kg/g} \times 7255 \text{ hr} = 2142 \text{ kg}$)</i>	

A1 Total on-site hydrogen fluoride emissions to air from scrubber in 2010 (kg): 2142

Input/Output Balance (intended for guidance purposes only; not required by regulation):

Use + Creation = Transformed + Destroyed + Contained in Product + On-site or Off-site Release + Disposal + Transfer

$$CI = TI + AI$$

$$20,000 \text{ kg} = 19,000 \text{ kg} + 2,142 \text{ kg}$$

Unaccounted for material: 1,142 kg

Comment on Input/Output Balance Results (intended for guidance purposes only):

After investigating the input/output balance results, no missing sources of data were found, and no calculation errors were found. It is likely that the difference in the input/output balance results from a combination of factors, including the following: The creation of hydrogen fluoride from the kilns prior to the scrubber is based on estimates of fluorine concentrations in the raw material, which can be highly variable due to its heterogeneous nature, and on the assumption that all of the fluorine is transformed into hydrogen fluoride during the drying process and kiln firing and cooling process. This may be an overly conservative assumption. Also, the destruction of hydrogen fluoride is based on the efficiency specifications of the scrubber, which may not reflect actual conditions. Finally, only three stack tests are used for the on-site emissions to air from the scrubber, which may not be presenting very accurate conditions considering the high variability in fluorine concentrations in the raw material, and the possible differences in hydrogen fluoride emission rate with temperature changes in the kiln during firing and cooling. Therefore, given the variation in data quality of the values used in the input/output balance, the input/output balance results are considered to be reasonable and acceptable.

8.0 Records Keeping And Forms

For toxics substance accounting, the Act and regulation requires that all documents and records to be kept on site for 7 years. It is the intention of the Ministry to provide electronic forms for the annual reports through the federal government's One-Window-for-National-Environmental-Reporting (OWNERS).

This section provides one approach to creating and maintaining records to not only meet the requirement of the regulation but also to facilitate consistency for subsequent year reporting.

One approach to overall data and records management is to create a computerized database of flow diagrams, calculations, and supporting data for each prescribed toxic substance. If a spreadsheet format is used, each sheet could provide documentation of each step of the data gathering, tracking and quantification process

The overall cover sheet of a spreadsheet could contain an overview of the contents of the spreadsheet along with instructions for the use of the spreadsheet. In this way, a standardized approach is created and documented. The next sheets could contain the illustrations showing stages and processes and process flow diagrams with detailed descriptions in logical order, from a big picture snap shot of the overall manufacturing stages to detailed process flow diagrams showing the movement of prescribed toxic substances. The process flow diagrams would then be followed by worksheets that provide the calculations used to track and quantify. The worksheets that provide the calculations would be linked to worksheets containing information derived from data sources. Lastly, the data sources could be scanned and attached to the file as reference records.

A facility may create a separate table (spreadsheet) per input/output stream, assign a unique identification to each stream, label the source, and provide a photo record of the stream or emission point in the table. In this way, all input and output points from each process are identified and may be referenced on the process flow diagram. This will enable a reviewer, such as a toxic substance reduction planner, to better understand the flow and fate of the prescribed toxic substance. This will also facilitate year to year comparisons of operations.

9.0 Other Requirements

9.1	Requirements When a Facility No Longer Has to Undertake Toxic Substance Accounting	84
9.2	Requirements When a Facility is Exempted from Undertaking Toxic Substance Accounting of Dioxins, Furans and Hexachlorobenzene	84

9.1 Requirements When a Facility No Longer Has to Undertake Toxic Substance Accounting

Although your facility may be subject to the Act and regulation at this time and thus required to undertake toxic substance accounting, it may not be in the future.

Your facility is no longer required to undertake toxic substance accounting for any substance if it:

- Has stopped operating in the manufacturing or mineral processing sector; or
- Has permanently reduced the number of employees at the facility to zero.

Your facility is no longer required to undertake toxic substance accounting for a specific substance if it:

- Has stopped using or creating the substance in all of its processes; or
- Is no longer required to provide information to NPRI for that substance because it failed to meet the activity, substance or employee thresholds.

Your facility is no longer required to undertake toxic substance accounting for acetone, if it is no longer required to report under O.Reg 127/01 (because it failed to meet the substance or employee thresholds for acetone). Acetone, a Phase II substance, does not need to be reported on until June 2013.

If any of the situations above apply to your facility, you are no longer required to undertake the toxic substance accounting requirements, but you must notify the Ministry. The regulation refers to this as an Exit Record. The Exit Record is due by June 1 of the year after any of the abovementioned situations occurs.

If, at a later date, your facility is once again subject to the Act and regulation because it meets all of

the criteria, it must once again, undertake toxic substance accounting.

9.2 Requirements When a Facility is Exempted from Undertaking Toxic Substance Accounting of Dioxins, Furans and Hexachlorobenzene

The regulation also offers a special exemption for three groups of substances: dioxins, furans and hexachlorobenzene.

If your facility is engaged in certain activities, NPRI requires it to provide information on dioxins, furans and hexachlorobenzene no matter what amount was released, disposed and transferred off-site for recycling.

If your facility is required to provide information to NPRI with respect to dioxins, furans or hexachlorobenzene but, in a given year, happens to fall below the estimated levels of quantification set out in the corresponding NPRI notice for that substance, it may apply for an exemption from meeting the requirements of the Toxics Reduction Act, 2009 and the regulation.

To qualify for the exemption, your facility must have determined through monitoring or source testing that the concentration of the dioxin, furan or hexachlorobenzene released, disposed of or transferred off site, in a given year, is less than the applicable estimated levels of quantification as set out in the NPRI Notice.

If your facility qualifies for an exemption it is no longer required to undertake the toxic substance accounting requirements, but it must submit a Record of Exemption to the Ministry. This record is due by June 1 in the year after your facility qualifies for exemption status.

Your facility must notify the Ministry for three consecutive years that it is below the estimated levels of quantification as set out in the NPRI

Notice, before all of the obligations under the Act and regulation cease to apply.

The exemption would last as long as your facility does not meet or exceed the estimated level of quantification set out in the NPRI Notice.

10.0 Glossary And Definitions

Please Note: Any time an NPRI Notice, Guide or other such reference is provided, the reader should be referring to the most recent update, regardless of the reference date in this toolkit.

approximately equal: within the margin of error of the supporting data and calculations

article: a manufactured item that does not release a substance listed in Schedule I of the Canada Gazette notice when it undergoes processing or other use

[source: 2008 NPRI Guide for Reporting]

by-product means a substance, listed in Schedule 1, which is incidentally manufactured, processed or otherwise used at the facility at any concentration, and released on site to the environment or disposed of.

[source: 2008 NPRI Guide for Reporting]

consumables: raw materials or products that are consumed or “used up” in a process eg. For arc welding, the electrode is a consumable.

contained in product: the amount of a prescribed toxic substance contained in a product leaving a process. This is not limited to products that are intended for sale and may include intermediate products as well.

destroyed: a toxic substance is destroyed if, after entering a process at a facility, the substance is changed into one or more substances that are not prescribed toxic substances.

[source: O. Reg. 455/09, s. 2(2)]

disposal: the final disposal of a substance to landfill, land application or underground injection, either on the facility site or at a location off the facility site, and includes treatment at a location off the facility site prior to final disposal.

[source: 2008 NPRI Guide for Reporting]

emission factors: numerical values that relate the quantity of substances emitted from a source to a common activity associated with those emissions, and can be categorized as:

- a) **published emission factors**, which are those that have been published by the Government of Canada, or another government or an industry association for application to an emission source that falls under the jurisdiction of the Government of Canada, or another government or to emission sources of a specific industry sector;
- b) **site-specific emission factors**, which are those that have been developed by an individual facility using their own specific emission-testing data and source-activity information.

[source: 2008 NPRI Guide for Reporting]

feedstock: raw materials (including prescribed toxic substances) derived from resource based operations, such as trees and crude oil

fugitive emission: a source associated with an area rather than a distinct point of emission. Some examples of fugitive sources are:

- leakage of gaseous contaminants from valves or pipes;
- leaks of contaminants around process operations;

- particulate emissions from roof vents on a process building;
- particulate emissions from storage piles or open material conveying

level of quantification: means, in respect of a substance, the lowest concentration that can be accurately measured using sensitive but routine sampling and analytical methods.

[source: 2008 NPRI Guide for Reporting]

NAICS: the North American Industry Classification System maintained for Canada by Statistics Canada as amended or revised from time to time.

[source: O.Reg. 455/09, s. 1(1)]

non-product outputs: by-products, solid wastes, liquid wastes, gaseous emissions and waste water effluents

NPRI: National Pollutant Release Inventory.

NPRI Toolbox: guidance available on how to meet NPRI requirements available in electronic form (available online: <http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=65A75CDF-1>)

process: an individual step in a manufacturing stage or mineral processing.

recycling: any activity that prevents a material or a component of the material from becoming a material destined for disposal.

[source: 2008 NPRI Guide for Reporting]

regulated community: manufacturing facilities in Ontario that fall under the NAICS Codes listed in the regulation, who are required to provide information to NPRI or report under O.Reg 127/01 for acetone.

release: the emission or discharge of a substance from the facility site to air, surface waters or land, and includes a spill or leak.

[source: 2008 NPRI Guide for Reporting]

significant process change

A reference to a significant process change at a facility is a reference to a change consisting of:

- a) the addition of a process at the facility that uses or creates a toxic substance, other than a process that is described in the current version of the toxic substance reduction plan for the substance at the facility; or
- b) an alteration to a process at the facility that uses or creates a toxic substance and that is described in the current version of the toxic substance reduction plan for the substance at the facility, if the alteration results in an increase in the use or creation of the substance in the process of at least 15 per cent from the quantifications set out in the current version of the plan.

[source: O. Reg. 455/09, s. 1(3)]

stage of manufacturing operation: the overall steps in a manufacturing operation, made up of individual processes, required to produce finished goods by transforming raw material and adding value to it for the purposes of making the finished product.

toxic substance: the following substances are prescribed as toxic substances for the purposes of the Act:

1. Any substance listed in Schedule 1 to the NPRI Notice, if the substance is in the form specified in that Schedule.
2. Acetone.

For greater certainty, a product that contains a substance listed in Schedule 1 in the NPRI Notice that is intended for human or animal consumption and that is manufactured at a food manufacturing or beverage manufacturing facility identified by a NAICS code commencing with the digits “311” or “3121” is not a toxic substance.

[source: O.Reg. 455/09, s. 3]

Transformed: a toxic substance is transformed if, after entering a process at a facility, the substance is changed into one or more other prescribed toxic substances.

[source: O.Reg. 455/09, s. 2(3)]

upset operating conditions: Non-normal, non-routine operating conditions that arise from an unexpected event such as a power outage or an equipment failure.

Workplace Hazardous Materials Information System (WHMIS) controlled product: a product classified as a controlled product in the WHMIS Regulation under the Occupational Health & Safety Act

11.0 References

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2. City of Toronto (1999). "A Guidance Manual for Pollution Prevention Plans" <<http://www.city.toronto.on.ca/bylaws/index.htm>>
3. Environment Canada (2003). "Pollution Prevention Planning Handbook." <<http://www.ec.gc.ca/NOPP/DOCS/P2P/hbook/en/index.cfm>>
4. Environment Canada (2008). "NPRI Guide for Reporting to the National Pollutant Release Inventory, Canadian Environmental Protection Act, 1999". <http://www.ec.gc.ca/inrp-npri/9EC63E8B-5F1A-47C5-B491-07BD46C76CC8/guide2008_e.pdf>
5. Freeman, Harry M. (1995). "Industrial Pollution Prevention Handbook"
6. Massachusetts Department of Environmental Protection (2009). "Toxics Use Reduction Planning and Plan Update Guidance" <<http://www.mass.gov/dep/toxics/laws/planguid.pdf>>
7. New Jersey Department of Environmental Protection (2002). "Prevention Planning: Meeting the Requirements under the New Jersey Pollution Prevention Act" <<http://www.nj.gov/dep/opppc/rules/guide.pdf>>
8. Ontario Ministry of Environment and Energy (1993). "Pollution Prevention Planning: Guidance Document and Workbook"
9. Ontario Ministry of the Environment (2009). "Guideline for Implementation of Air Standards in Ontario (GIASO), Version 2.0." Guidance to Support the Ministry of the Environment's Risk Framework for Requests for Altered Air Standards and Upper Risk Thresholds under Ontario Regulation 419/05 Air Pollution – Local Air Quality (as amended) made under the Environmental Protection Act. <<http://www.ene.gov.on.ca/envision/gp/5166e02.pdf>>
10. Ontario Ministry of the Environment (2009b). "Procedure for Preparing and Emissions Summary and Dispersion Modelling Report, Version 3.0." Guidance for Demonstrating Compliance with Ontario Regulation 419/05 Air Pollution – Local Air Quality made under the Environmental Protection Act. <<http://www.ene.gov.on.ca/envision/gp/3614e03.pdf>>
11. Ontario Ministry of the Environment (2009c). "Air Dispersion Modelling Guideline for Ontario, Version 2.0." Guidance for Demonstrating Compliance with The Air Dispersion Modelling Requirements set out in Ontario Regulation 419/05 Air Pollution – Local Air Quality made under the Environmental Protection Act. <<http://www.ene.gov.on.ca/envision/gp/5165e02.pdf>>
12. United States Environmental Protection Agency Sector Notebooks for Compliance Assistance. <<http://www.epa.gov/Compliance/resources/publications/assistance/sectors/notebooks/index.html>>
13. United States Environmental Protection Agency (1990). "Guides to Pollution Prevention - The Commercial Printing Industry."
14. United States Environmental Protection Agency (1992). "Facility Pollution Prevention Guide EPA/600/R-92/088"
15. Ontario Ministry of the Environment (2008). "Discussion Paper: Creating Ontario's Toxics Reduction Strategy"

16. Ontario Ministry of the Environment (2009). "Backgrounder: The Proposed Toxics Reduction Act Planned Consultations And Next Steps"
17. Ontario Ministry of the Environment Toxics Reduction Website. <<http://www.ene.gov.on.ca/en/toxics/index.php>>
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19. David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Fourth Edition, Prentise Hall of Canada Ltd, Toronto, 1982
20. Ontario Ministry of Environment, Ontario Air and Noise Best Practices, Vapour Emission from a Solvent Waste Storage Tank, June 3, 2009.
21. Ontario Ministry of Environment, Protocol for the Sampling and Analysis of Industrial/ Municipal Wastewater, January 1999.

12.0 Toxic Substance Accounting Resources

The following is a list of resources that have been referenced in the toolkit.

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2. The Merck Index, 14th Edition, Merck & Co., 2006.
3. Karel Verschueren, Handbook of Environmental Data on Organic Chemicals, 5th Edition, John Wiley & Sons, Incorporated, 2009
4. Robert H. Perry, Perry's Chemical Engineer's Handbook, 7th Edition, McGraw-Hill, 1997.
5. David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Fourth Edition, Prentice Hall of Canada Ltd, Toronto, 1982
6. Air & Waste Management Association, Air Pollution Engineering Manual, 2nd Edition, John Wiley & Sons, Incorporated, 2000
7. US Agency for Toxic Substances and Disease Registry (ATSDR) web-site <http://www.atsdr.cdc.gov/>
8. Ontario Ministry of the Environment (MOE), Municipal/Industrial Strategy for Abatement (MISA), Development Document(s), such as:

"The Development Document for the Draft Effluent Monitoring Regulation for the Iron and Steel Sector", February 1989

"The Development Document for the Effluent Monitoring Regulation for the Metal Casting Sector", January 1990

"Development Document for the Inorganic Chemical Sector Effluent Limits Regulation", September 1994

"The Development Document for the Draft Effluent Monitoring Regulation for the Organic Chemical Manufacturing Sector", May 1989

"The Development Document for the Draft Effluent Monitoring Regulation for the Ontario Mineral Industry: Group B Industrial Minerals Sector", October 1989
9. MOE's "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater", August 1994
10. United States (US) Environmental Protection Agency (EPA) Sector Notebooks website <http://www.epa.gov/Compliance/resources/publications/assistance/sectors/notebooks/index.html>
11. USEPA Factor Information Retrieval (FIRE) Data System website www.epa.gov/ttn/chief/software/fire/index.html.
12. USEPA Locating and Estimating (L&E) website www.epa.gov/ttn/chief
13. U.S. State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Officials (ALAPCO) (www.cleanairworld.org/).
14. MOE Regulation 127/01 – Airborne Contaminant Discharge Monitoring and Reporting website <http://www.ene.gov.on.ca/envision/monitoring/monitoring.htm>

15. Environment Canada National Pollutant Release Inventory (NPRI) on-line toolbox (see www.ec.gc.ca/pdb/npri/npri_home_e.cfm).
16. US EPA Compilation of Air Pollutant Emission Factors Document Number AP-42 (www.epa.gov/ttn)
17. Environment Canada, "Technical Resource Guide Prepared to Assist Wet Processing Textile Mills Required to Prepare and Implement Pollution Prevention Plans", 2004
18. EPA Guides to Pollution Prevention
The Printed Circuit Board Manufacturing Industry. (EPA/625/7-90/002) 1990.
The Pesticide Formulating Industry. (EPA/625/7-90/004) 1990.
The Paint Manufacturing Industry. (EPA/625/7-90/005) 1990.
The Fabricated Metal Industry. (EPA/625/7-90/006) 1990.
The Commercial Printing Industry. (EPA/625/7-90/008) 1990.
Selected Hospital Waste Streams. (EPA/625/7-90/009) 1990.
Research and Educational Institutions. (EPA/625/7-90/010) 1990.
The Photoprocessing Industry. (EPA/625/7-91/012) 1991.
The Auto Repair Industry. (EPA/625/7-91/013) 1991.
Fiberglass Reinforced and Composite Plastics. (EPA/625/7-91/014) 1991.
Marine Maintenance and Repair. (EPA/625/7-91/015) 1991.
The Automotive Refinishing Industry. (EPA/625/7-91/016) 1991.
The Pharmaceutical Industry. (EPA/625/7-91/017) 1991. ±
19. City of Toronto, Environmental Regulations and Best Management Practices For Petroleum Facilities in the City of Toronto, www.toronto.ca/water/protecting_quality/pollution_prevention/pdf/automotive_repair.pdf
20. MOE, Sewer Use Best Management Practices (BMP) Documents
 - Textile Sector <http://www.ene.gov.on.ca/publications/6203e.pdf>
 - Fabricated Metal Products Sector <http://www.ene.gov.on.ca/publications/6204e.pdf>
 - Motor Vehicle Parts Manufacturing Sector <http://www.ene.gov.on.ca/publications/6205e.pdf>
 - Automotive Repair and Maintenance <http://www.ene.gov.on.ca/publications/6206e.pdf>
 - Dry Cleaning and Laundry Services <http://www.ene.gov.on.ca/publications/6207e.pdf>
 - Chemical Manufacturing Sector <http://www.ene.gov.on.ca/publications/6208e.pdf>
 - Chemical Manufacturing Sector, Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filament Sector <http://www.ene.gov.on.ca/publications/6209e.pdf>
 - Chemical Manufacturing Sector : Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing Sector <http://www.ene.gov.on.ca/publications/6210e.pdf>
 - Chemical Manufacturing Sector, Paint Coating, and Adhesive Manufacturing Sector <http://www.ene.gov.on.ca/publications/6211e.pdf>
21. Varangu, L.K. (2004). "Technical Resource Guide Prepared to Assist Wet Processing Textile Mills Required to Prepare and Implement Pollution Prevention Plans," Canadian Centre for Pollution Prevention in association with Fintex Mechanical and Process Inc. report for Environment Canada.
22. NEWMOA, Pollution Prevention in Machining and Metal Fabrication, A Manual for Technical Assistance Providers, March 2001 <http://www.newmoa.org/prevention/topic/sub/23/NEWMOAmanual.pdf>

Appendix A – List Of 47 Priority Substances

Table A

Item	Column 1 Substance prescribed under subsection 3 (1)	Column 2 CAS#	Column 3 NPRI Part
1.	Acetaldehyde	75-07-0	1
2.	Acrylamide	79-06-1	1
3.	Aluminum ¹	7429-90-5	1
4.	Antimony ²	**	1
5.	Arsenic ³	**	1
6.	Asbestos ⁴	1332-21-4	1
7.	Benzene	71-43-2	1,5
8.	Biphenyl	92-52-4 1	1
9.	1,3 –Butadiene	106-99-0	1,5
10.	Cadmium ⁵	**	1
11a.	Benzoyl chloride	98-88-4	1
11b.	Benzyl chloride	100-44-7	1
12.	Chlorine	7782-50-5	1
13.	Chromium ⁶	**	1
14.	Cobalt ⁷	**	1
15.	Copper ⁸	**	1
16.	Creosote	8001-58-9	5
17.	Cyanides ⁹	**	1
18.	1,2-Dichloroethane	107-06-2	1,5
19a.	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	3

Item	Column 1 Substance prescribed under subsection 3 (1)	Column 2 CAS#	Column 3 NPRI Part
19b.	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	3
19b.	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	3
19c.	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	39227-28-6	3
19d.	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3	3
19e.	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7	3
19f.	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	35822-46-9	3
19g.	Octachlorodibenzo-p-dioxin	3268-87-9	3
19h.	2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	3
19i.	2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	3
19j.	1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	3
19k.	1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	3
19l.	1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	3
19m.	1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	3
19n.	2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	3
19o.	1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	3
19p.	1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	3
19q.	Octachlorodibenzofuran	39001-02-0	3
20.	Epichlorohydrin	106-89-8	1
21.	Ethylbenzene	100-41-4	1
22.	Ethylene Oxide	75-21-8	1
23.	Formaldehyde	50-00-0	1,5
24.	Hexachlorobenzene	118-74-1	3
25.	Hexavalent Chromium compounds	**	1
26.	Hydrochloric acid	7647-01-0	1
27.	Lead ^{10,11}	**	1
28.	Manganese ¹²	**	1

Item	Column 1 Substance prescribed under subsection 3 (1)	Column 2 CAS#	Column 3 NPRI Part
29.	Mercury ¹³	**	1,2
30.	Methanol	67-56-1	1,5
31.	Nickel ¹⁴	**	1
32.	Phenol ¹⁵	108-95-2	1
33.	p,p'-methylenebis (2-chloroaniline)	101-14-4	1
34.	Selenium ¹⁶	**	1
35.	Silver ¹⁷	**	1
36.	Styrene Oxide	96-09-3	1
37a.	Sulphuric acid	7664-93-9	1
37b.	Dimethyl sulphate	77-78-1	1
37c.	Diethyl sulphate	64-67-5	1
38.	Tetrachloroethylene	127-18-4	1
39.	Thorium Dioxide	1314-20-1	1
40.	Toluene	108-88-3	1,5
41a.	Acenaphthene	83-32-9	2
41b.	Acenaphthylene	208-96-8	2
41c.	Anthracene	120-12-7	1
41d.	Benzo(a)anthracene	56-55-3	2
41e.	Benzo(a)phenanthrene	218-01-9	2
41f.	Benzo(a)pyrene	50-32-8	2
41g.	Benzo(b)fluoranthene	205-99-2	2
41h.	Benzo(e)pyrene	192-97-2	2
41i.	Benzo(g,h,i)perylene	191-24-2	2
41j.	Benzo(j)fluoranthene	205-82-3	2
41k.	Benzo(k)fluoranthene	207-08-9	2
41l.	Dibenzo(a,j)acridine	224-42-0	2

Item	Column 1 Substance prescribed under subsection 3 (1)	Column 2 CAS#	Column 3 NPRI Part
41m.	Dibenzo(a,h)acridine	226-36-8	2
41n.	Dibenzo(a,h)anthracene	53-70-3	2
41o.	Dibenzo(a,e)fluoranthene	5385-75-1	2
41p.	Dibenzo(a,e)pyrene	192-65-4	2
41q.	Dibenzo(a,h)pyrene	189-64-0	2
41r.	Dibenzo(a,i)pyrene	189-55-9	2
41s.	Dibenzo(a,l)pyrene	191-30-0	2
41t.	7H-Dibenzo(c,g)carbazole	194-59-2	2
41u.	7,12-Dimethylbenz(a)anthracene	57-97-6	2
41v.	Fluoranthene	206-44-0	2
41w.	Fluorene	86-73-7	2
41x.	Indeno(1,2,3-c,d)pyrene	193-39-5	2
41y.	3-Methylcholanthrene	56-49-5	2
41z.	5-Methylchrysene	3697-24-3	2
41aa.	Naphthalene	91-20-3	1
41ab.	1-Nitropyrene	5522-43-0	2
41ac.	Perylene	198-55-0	2
42.	Trichloroethylene	79-01-6	1
43.	Triethylamine	121-44-8	1
44.	Vanadium ¹⁸	7440-62-2	1
45.	Vinyl Chloride	75-01-4	1
46.	Xylene ¹⁹	1330-20-7	1,5
47.	Zinc ²⁰	**	1

Notes to Table A:

****** no single CAS number applies to this substance

¹ fume or dust

² and its compounds

³ and its compounds

⁴ friable form

⁵ and its compounds

⁶ and its compounds, except hexavalent chromium compounds

⁷ and its compounds

⁸ and its compounds

⁹ ionic

¹⁰ and its compounds, except tetraethyl lead (CAS No. 78-00-2)

¹¹ does not include lead (and its compounds) contained in stainless steel, brass or bronze alloys.

¹² and its compounds

¹³ and its compounds

¹⁴ and its compounds

¹⁵ and its salts. The CAS Number corresponds to the weak acid or base. However, this substance includes the salts of these weak acids and bases. When calculating the weight of these substances and their salts, use the molecular weight of the acid or base, not the total weight of the salt.

¹⁶ and its compounds

¹⁷ and its compounds

¹⁸ (except when in an alloy) and its compounds

¹⁹ all isomers, including the individual isomers of xylene: m-xylene (CAS No. 108-38-3), o-xylene (CAS No. 95-47-6) and p-xylene (CAS No. 106-42-3)

²⁰ and its compounds

Note: A footnote that qualifies the listing of a toxic substance in this Table is the same footnote that qualifies its listing in Schedule 1 to the NPRI Notice.

Appendix B – Using A Team Approach

Establishing a Cross-functional Team

The value and importance of management commitment to and support of toxic substance reduction planning cannot be overstated. The most successful toxic substance reduction initiatives come with the commitment and support of top management as well as the production level staff. Appropriate management decision makers should be informed and committed to the plan during its development and throughout the process. This may best be accomplished by incorporating the toxic substance reduction planning process, including toxic substance accounting, into existing business systems, including environmental management systems (EMS).

While executives and managers will assign priorities and set the tone for the toxic substance reduction planning program, the support of production-level employees will also have a significant effect on its success. Production level employees understand normal operating conditions and are also often tasked with dealing with operating conditions that are non-routine or unexpected such as process “upsets” caused by a break in a line or seal or an electricity outage or spills. Production level employees will also likely be responsible for the implementation of any changes as a result of the overall findings of

the toxic substance reduction planning process. The support of production level employees is essential for the successful implementation of any toxic substance reduction option that involves a process level change.

Other members of the cross-functional team could be people with direct responsibility for and knowledge of the characteristics of, the volume of, and the cost associated with the substances and materials used and the outputs produced. A multidisciplinary team is likely to be more successful in achieving a comprehensive assessment. This team could also be instrumental in the toxic substance reduction planning requirements of option definition and providing answers to the question of how the toxic substance reduction plan fits into the overall facility operations. To the extent practical, facilities should consider business managers, chemists, biotechnologists, toxicologists, engineers, supervisors, and production workers as well as accounting and purchasing, marketing and sales, and environmental and health and safety staff when selecting the team members.

Table 3 provides a list of potential cross-functional team members and their potential role.

Table 5: Roles of Cross-functional Team Members

Team Representative	Role
Management	<p><i>Demonstrate corporate commitment.</i></p> <p><i>Set and enforce long-term goals.</i></p> <p><i>Have authority to implement changes.</i></p> <p><i>If it is the highest ranking employee, certify report which will include accounting information.</i></p>
Engineering and Design	<p><i>Provide information on current processes, including identification of where toxic substances are used, created and contained in product</i></p>
Environmental Compliance	<p><i>Characterization of waste streams and releases to air, water, etc.</i></p> <p><i>Calculate treatment and disposal costs.</i></p> <p><i>Understands when testing is a requirement of Regulations</i></p> <p><i>Spills data</i></p>
Accounting and Purchasing	<p><i>Amount of substances purchased</i></p> <p><i>Cost of substances</i></p> <p><i>Cost of personal protective equipment (PPE)</i></p> <p><i>Receives MSDS</i></p>
Production Level Staff	<p><i>Provide accurate descriptions of production operations and conditions, including identification of where toxic substances are used and created</i></p> <p><i>Accurate data on usage</i></p> <p><i>Information on spills</i></p> <p><i>Information on upsets</i></p>
Maintenance Staff	<p><i>Provide descriptions of ancillary operations</i></p> <p><i>Accurate data on usage of maintenance materials/products</i></p> <p><i>Information on upsets</i></p>

Team Representative	Role
Health and Safety	<i>Provide industrial hygiene data</i> <i>Provide data on health and safety effects of toxic substances</i> <i>Evaluate effects of toxic reduction on worker health and safety.</i>
Marketing/Sales	<i>Provide information on what toxic substances are contained in product</i> <i>Provide information on customer specifications</i> <i>Understands export requirements</i>

Using the team approach for the preliminary data gathering exercise

Additional resources that are not employees of the facility but may be considered to be extended members or support for members of the cross-functional team may include:

- Suppliers of process and abatement equipment
- Suppliers of raw materials
- Laboratories who develop material safety data sheets (MSDSs) for finished products
- Waste management/treatment contractors
- Consultants who assist in environmental or health and safety reporting, testing, design of abatement programs
- Representatives from industry associations

A potential approach to the effective use of the team members and production-level staff time is to:

1. Discuss and agree upon the scope and objectives of the site walk-through, inspection, or assessment. The scope review should include whether the purpose is a general site walk-through to document stages and processes, whether it is a detailed inspection of a process, or whether it is a follow-up assessment to clarify or gather

more data to fill a specific data gap. The objectives should include determining the answers to the following questions:

- Which production stages and processes use the toxic substance or products that contain toxic substances? What is the purpose of the substance or product? Where is it stored? How is it transferred to the process? How is it used in the process? What happens to the toxic substance contained in the product? Does it become part of the manufactured product? Does it end up in a waste, air, or wastewater stream? Does it get transformed into another toxic substance or is it destroyed?
- Which stages and processes create toxic substances? How does the toxic substance get created? What are the specific operating conditions (chemical mixing, temperature, pressure) that create the substance? What happens to the toxic substance that is created? Does it become part of the manufactured product? Does it end up in a waste, air, or wastewater stream? Does it get transformed into another toxic substance or is it destroyed?
- How much toxic substance is contained in product?
- How does the toxic substance get transferred from one process to another? Is it quantifiable?

- Where do data gaps exist?
- How efficient is the production process and the various steps of that process?
- Are good operating practices in force to minimize the use and creation of toxic substances and the creation of waste streams?

2. Schedule the inspection to coincide with the particular operation that uses or creates the toxic substance of interest. Follow the toxic substance or product that contains the toxic substance from receipt at facility, to on-site storage location, to transfer to location of use, through use, to end-product. Note where and how the substance is transferred from one process to another (i.e. “dragged” from one bath to another, transferred via piping from granulator to extrusion equipment), where it is released to air, water, land, and waste streams and where it may be transformed or destroyed throughout the overall manufacturing operation.
3. Observe the processes at different times during normal operations, and if needed, during different shifts, especially when toxic substance use is highly dependent on human involvement such as painting or parts cleaning processes. Processes may be operated differently from the methods described in their standard operating procedures, or the equipment may have been modified.
4. Observe the operation during cleaning and maintenance operations to identify unique waste and by-product generation not present during normal operations.
5. Interview production-level staff. Discuss the materials handling, dosing, operating conditions, and waste generation aspects of the operation. Ask what the function is of any product that contains toxic substances and

the quantity used per production unit. Ask the likelihood of process upsets or non-ideal conditions and how these are tracked. This is for situations where upsets or non-ideal conditions could result in the creation of a toxic substance.

6. Photograph or videotape the operation. Visuals are helpful to better understand the manufacturing operation. As well, pictures are valuable in the absence of plant layout drawings. Many details may be captured in pictures.
7. Observe the “housekeeping” aspects of the operation. Check for signs of spills or leaks. Visit the maintenance shop and ask about problems in keeping the equipment leak-free. Also enquire about maintenance and calibration activities that are required to ensure that equipment is performing as per design. Note any areas where odours and fumes are evident.
8. Include indoor and outdoor components of the operation. Particulates or oil mists that leave a facility via roof vents often end up in the stormwater stream.

The site inspection should be performed carefully, even though the cross-functional team members who are employed at the facility will likely all be familiar to some extent with the work-site being reviewed. Personnel regularly involved with a particular process will often see it in a new light when performing an assessment whose primary focus is toxic substance accounting. Those who are not involved in the day-to-day operation of a particular process will also add value to the team, as they will see and question conditions taken for granted by those involved in the day-to-day process.

Appendix C – Master Documents And Meeting The Requirements For Stage And Process Records

Many facilities may face a situation where substances may travel through the facility in the same path and are used in many common processes and therefore are looking for opportunities to meet the stage and process record requirements of accounting as efficiently as possible. A possible approach for such a situation is to develop a “master” description of stages that use and/or create the substances; a “master” process flow diagram that illustrates the movement of the substances through the processes. The quantification at the process level would be on a substance basis because the quantities may differ despite the movements being similar.

Using a fictional auto assembly facility as an example, the following may be one approach for master documents and still meet the requirements for records per substance.

Master Description of stages and how each stage is divided into processes

The fictional auto assembly facility has numerous substances that are captured under the Act and regulation which vary from metals in the automobile’s structure, VOCs in the paint and substances used for wastewater treatment. The facility has identified four (4) stages that use and/or create these substances:

1.0 Body Shop Stage

The Body Shop Stage is divided into two processes: stamping and welding.

In the stamping process, metal is received as blanks or coils and is stamped or pressed into the required shape for the vehicle body. Stamped metal is sent to the body shop for initial assembly. In the weld process, stamped panels and welded sub-assemblies are fitted and welded together to create the outer shell of the vehicle, and sealers are applied. The completed “white body” is sent to the paint shop.

2.0 Paint Shop Stage

The paint stage commonly contains the following processes:

- Pre-treatment
- Electroplating (E-coat) application
- E-coat oven
- Sealer application
- Painting Application (which includes primer, base and clear coat application and cleaning)
- Oven(s)

The specific coating processes in a vehicle assembly paint shop may vary from facility to facility but generally include the following steps. Dip tanks are used for pre-treatment and electro-deposition coating (E-coat) for corrosion protection.

This is followed by curing of E-coat in a heated oven, after which sealers and sound deadeners are applied. The vehicle then undergoes further preparation through application of primer and/or an anti-chip primer, after which it is cured in ovens prior to application of the topcoat. The topcoat typically consists of the application of a basecoat (colour) and clearcoat combination, after which the vehicle body passes through a final topcoat oven.

3.0 Final Assembly Stage

This stage generally involves three processes: interior/exterior parts installation, fluid fill and vehicle inspection/shipping. The installation of chassis, interior and exterior parts, as well as fluid fill and air conditioning charging are included in the processes.

4.0 Storage

This stage describes the inventory or storage of materials that contain the substances. Substances may be taken from storage or a temporary holding place to be used in the body shop, painting or finally assembly stage.

Record for Substance X – Regulation s. 12(2)1 Description of Stages and How Stages are Divided into Process

Refer to the Master Stage description for the Facility, Substance X is used in the Storage and Final Assembly stages. Refer to the Master Process Flow Diagram for division of each stage into processes.

Master Process Flow Diagram – Showing flow of groups of substances at the process level

The fictional auto assembly facility developed a master process flow diagram that describes how each stage of the facility is divided into one or

more processes and illustrates the relationship between the processes. (see diagram below). The master diagram does not specifically reference any particular substance but the approach the fictional facility took was to use the process name to link the facility substance quantification spreadsheets to the process flow diagram. Using this approach, the quantification spreadsheets list each process using the substance and the amount that enters, is created in the process, and leaves the process via destruction or transformation, release, disposal or transfer or contained in the product as required by regulation.

Records for Substance X – Process Flow Diagram and Description of the Process

Refer to the Master Process Flow Diagram.
Information required under the Act s.4(1)4(i) regarding substance use or creation in each process and by Regulation s.12(2)2.

Storage Process –

How – Received in drums stored in a ventilated room(s); leaves process via fork-lift in drums

When – Received as required based on just in time delivery to maintain production

Where – Storage

Why – Key ingredient in windshield washer fluid

Fluid Fill Process –

How – Delivered to line in drums via forklift, manually added to vehicle, leaves in product

When – During windshield washer fluid fill

Where – Fluid fill process

Why – Key ingredient in windshield washer fluid

Master Process Flow Diagram

